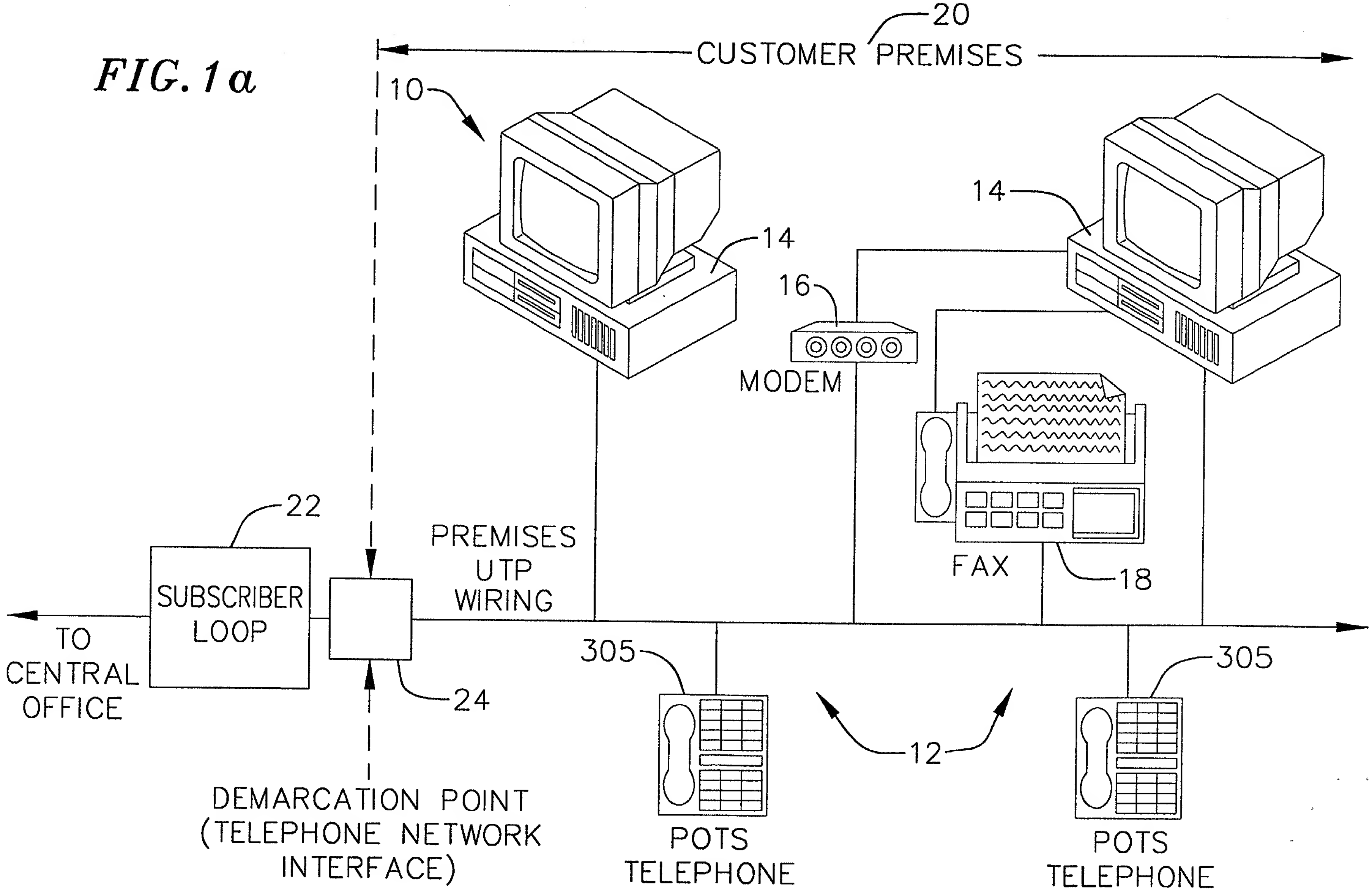
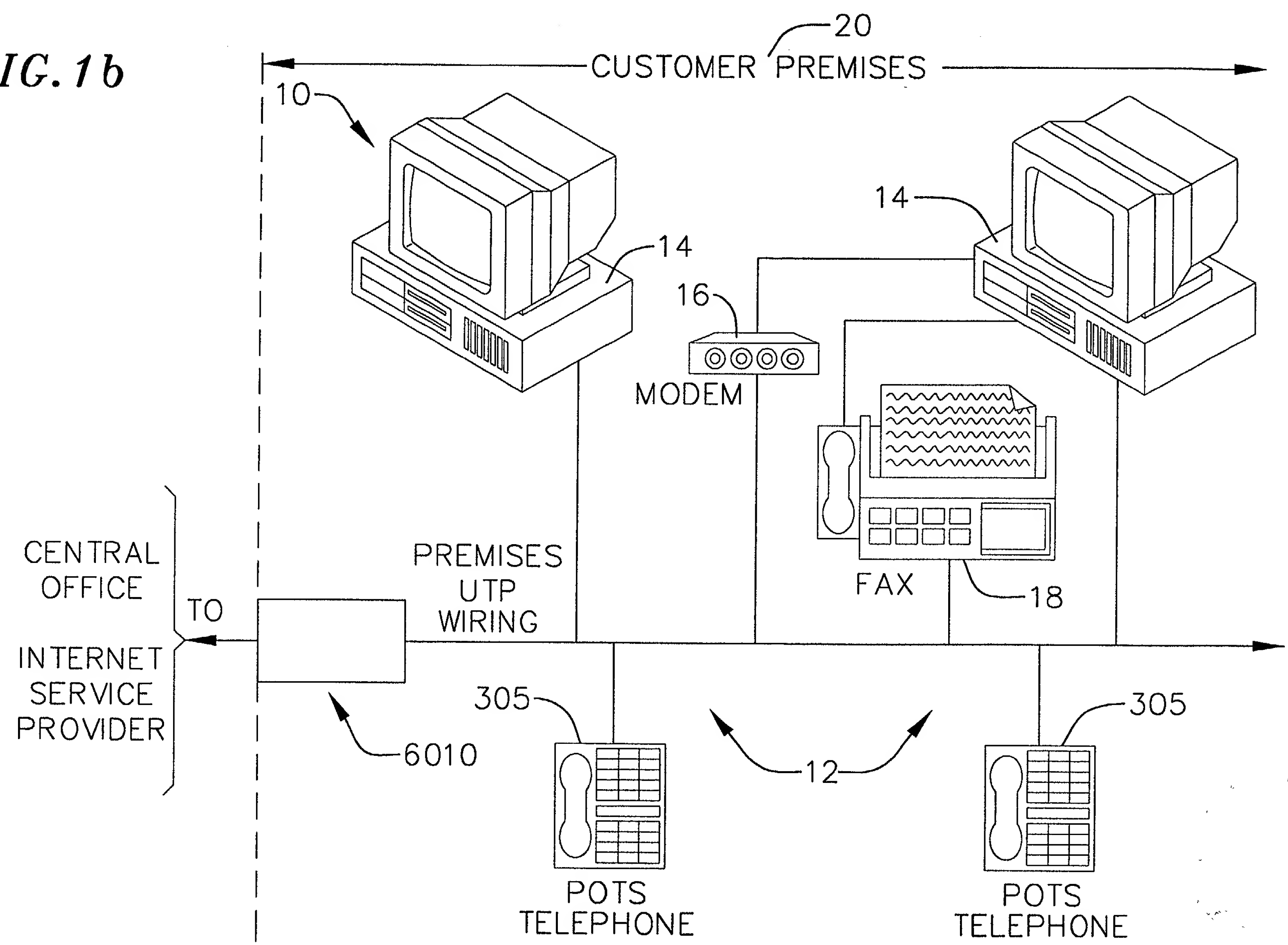
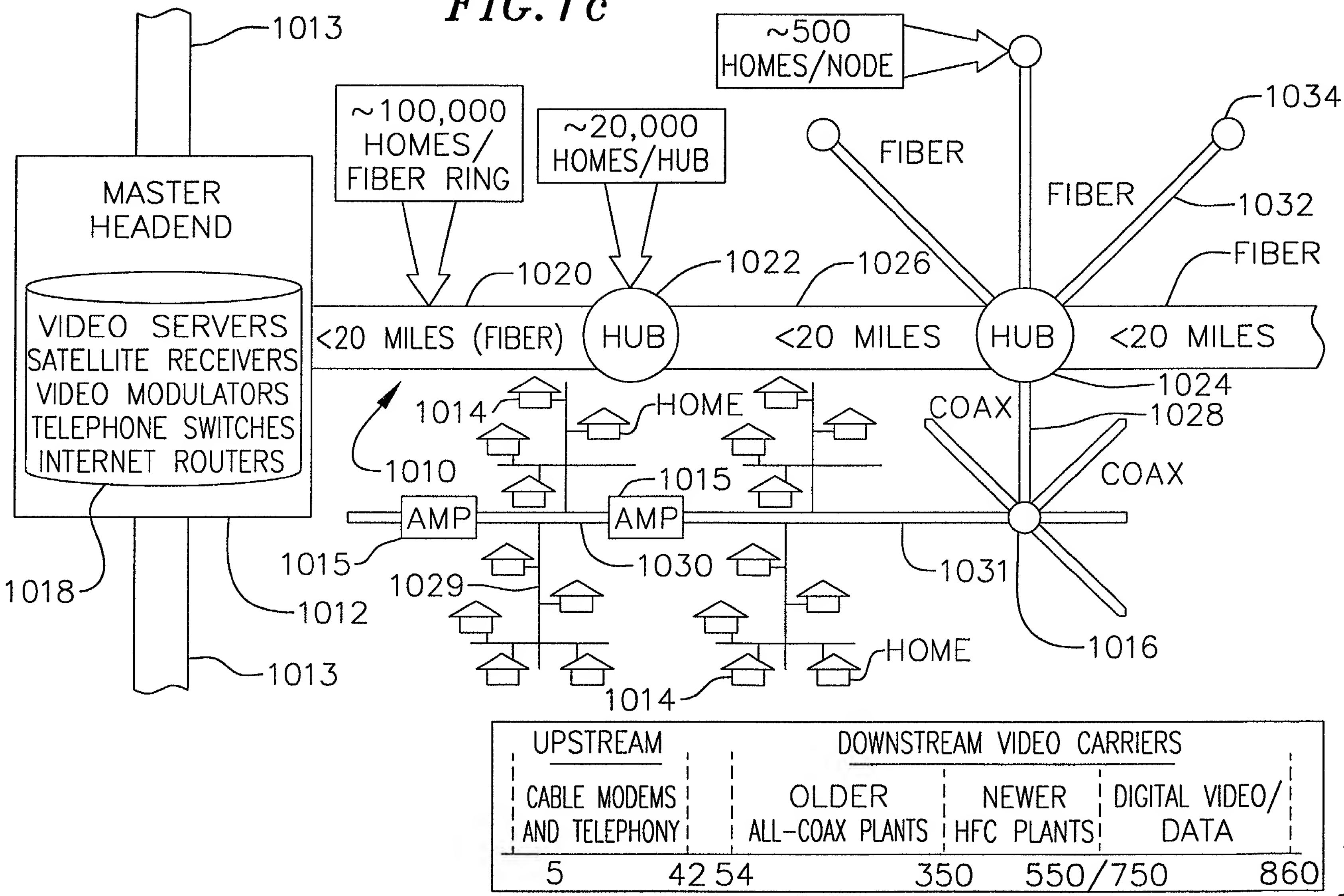
FIG. 1a


CUSTOMER PREMISES
20
10
14
14
16
MODEM
FAX
18
22
SUBSCRIBER LOOP
TO CENTRAL OFFICE
PREMISES UTP WIRING
24
DEMARCATION POINT (TELEPHONE NETWORK INTERFACE)
305
POTS TELEPHONE
12
305
POTS TELEPHONE

#3

FIG. 1b

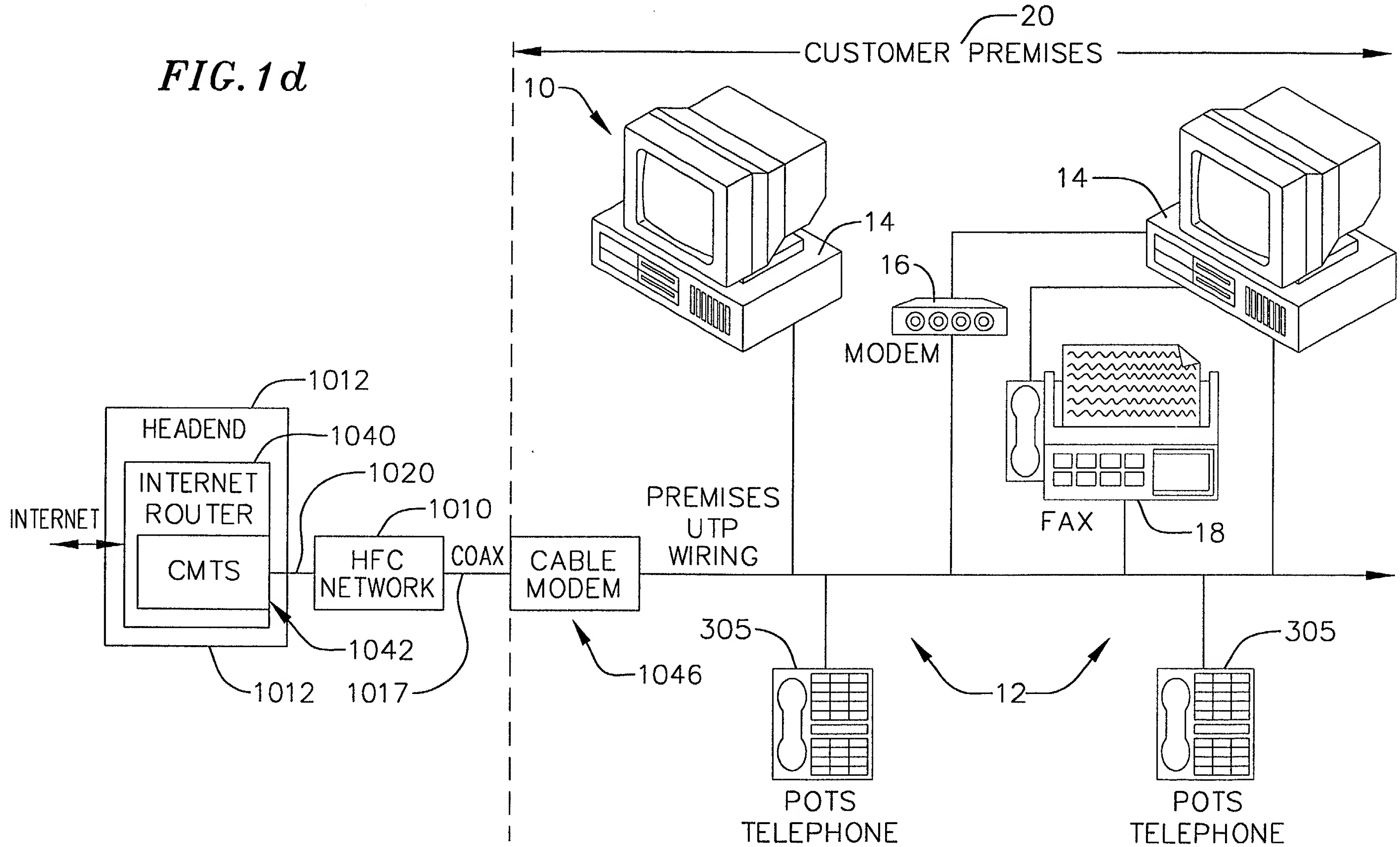

20
CUSTOMER PREMISES
10
14
14
16
MODEM
CENTRAL
OFFICE
TO
INTERNET
SERVICE
PROVIDER
PREMISES
UTP
WIRING
FAX
18
305
6010
12
305
POTS
TELEPHONE
POTS
TELEPHONE



1013
MASTER HEADEND
VIDEO SERVERS
SATELLITE RECEIVERS
VIDEO MODULATORS
TELEPHONE SWITCHES
INTERNET ROUTERS
1018
1012
1013
~100,000 HOMES/ FIBER RING
~20,000 HOMES/HUB
~500 HOMES/NODE
1020
1022
1026
<20 MILES (FIBER)
HUB
<20 MILES
HUB
<20 MILES
FIBER
FIBER
FIBER
1034
1032
1024
1028
COAX
COAX
1010
1014
HOME
1015
AMP
AMP
1015
1030
1029
1031
1016
HOME
1014
UPSTREAM
CABLE MODEMS AND TELEPHONY
DOWNSTREAM VIDEO CARRIERS
OLDER ALL-COAX PLANTS
NEWER HFC PLANTS
DIGITAL VIDEO/ DATA
5
42 54
350
550/750
860

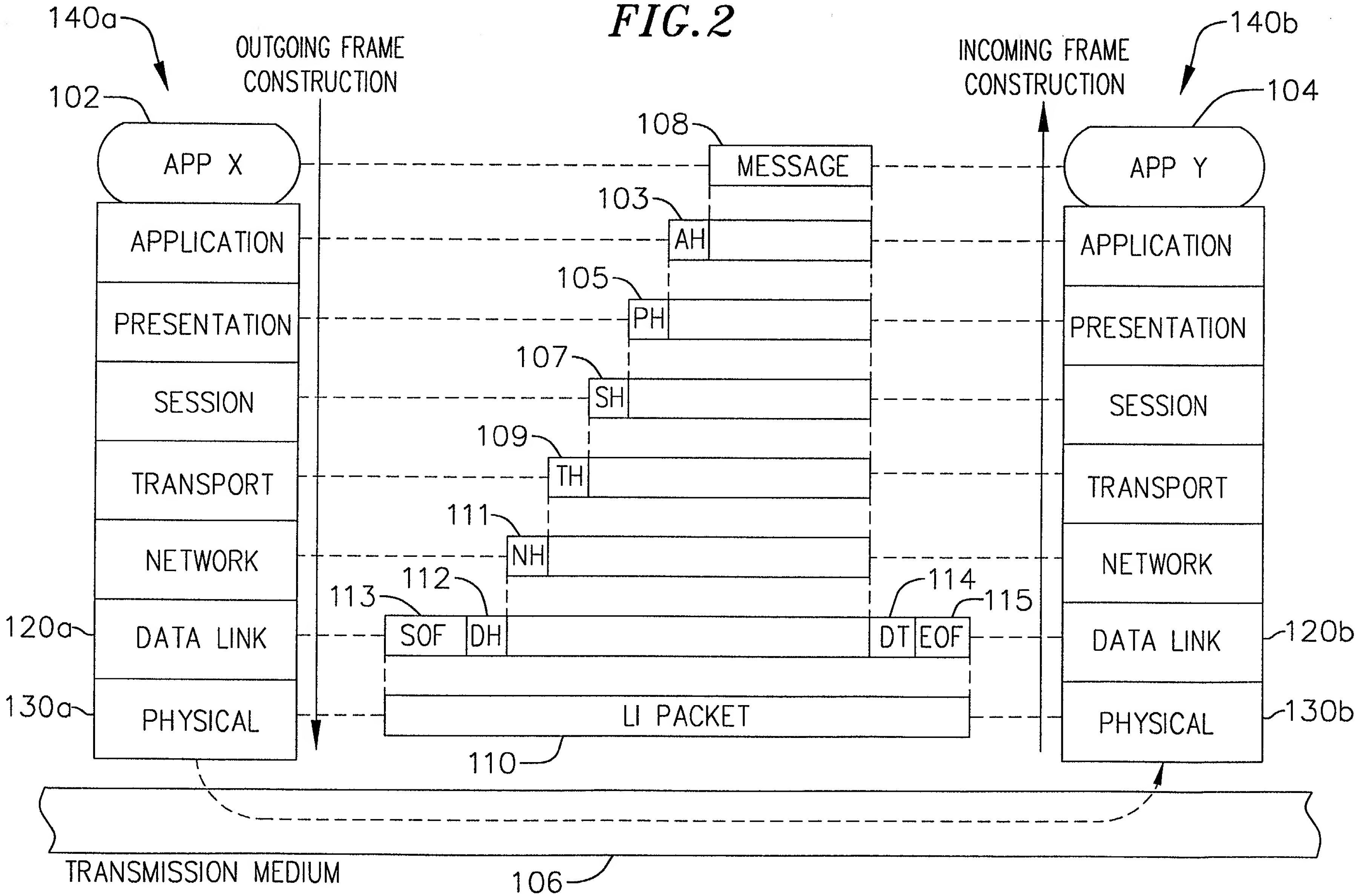
FIG. 1c

FIG. 1d



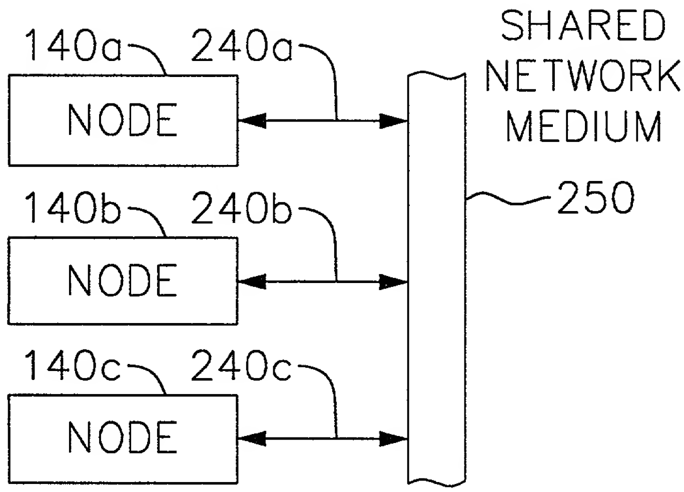
CUSTOMER PREMISES
20
10
14
14
16
MODEM
FAX
18
1012
HEADEND
1040
INTERNET ROUTER
CMTS
INTERNET
1020
1010
HFC NETWORK
COAX
CABLE MODEM
PREMISES UTP WIRING
1042
1012
1017
1046
305
305
12
POTS TELEPHONE
POTS TELEPHONE

FIG.2



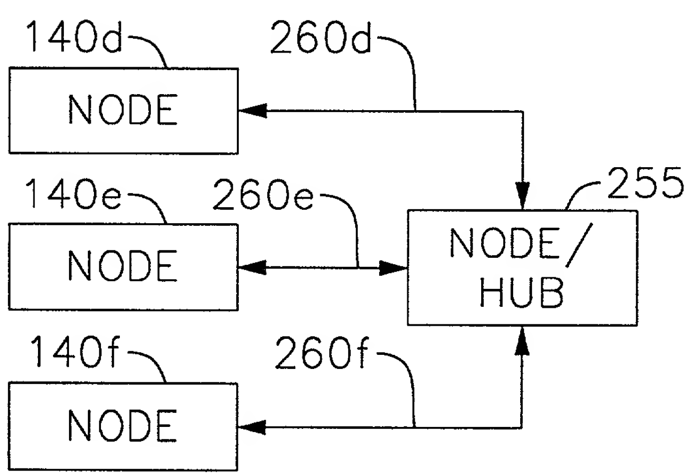
140a
102
APP X
APPLICATION
PRESENTATION
SESSION
TRANSPORT
NETWORK
DATA LINK
PHYSICAL
120a
130a
OUTGOING FRAME CONSTRUCTION
108
MESSAGE
103
AH
105
PH
107
SH
109
TH
111
NH
113
SOF
112
DH
114
DT
115
EOF
LI PACKET
110
INCOMING FRAME CONSTRUCTION
140b
104
APP Y
APPLICATION
PRESENTATION
SESSION
TRANSPORT
NETWORK
DATA LINK
PHYSICAL
120b
130b
TRANSMISSION MEDIUM
106

FIG. 3a



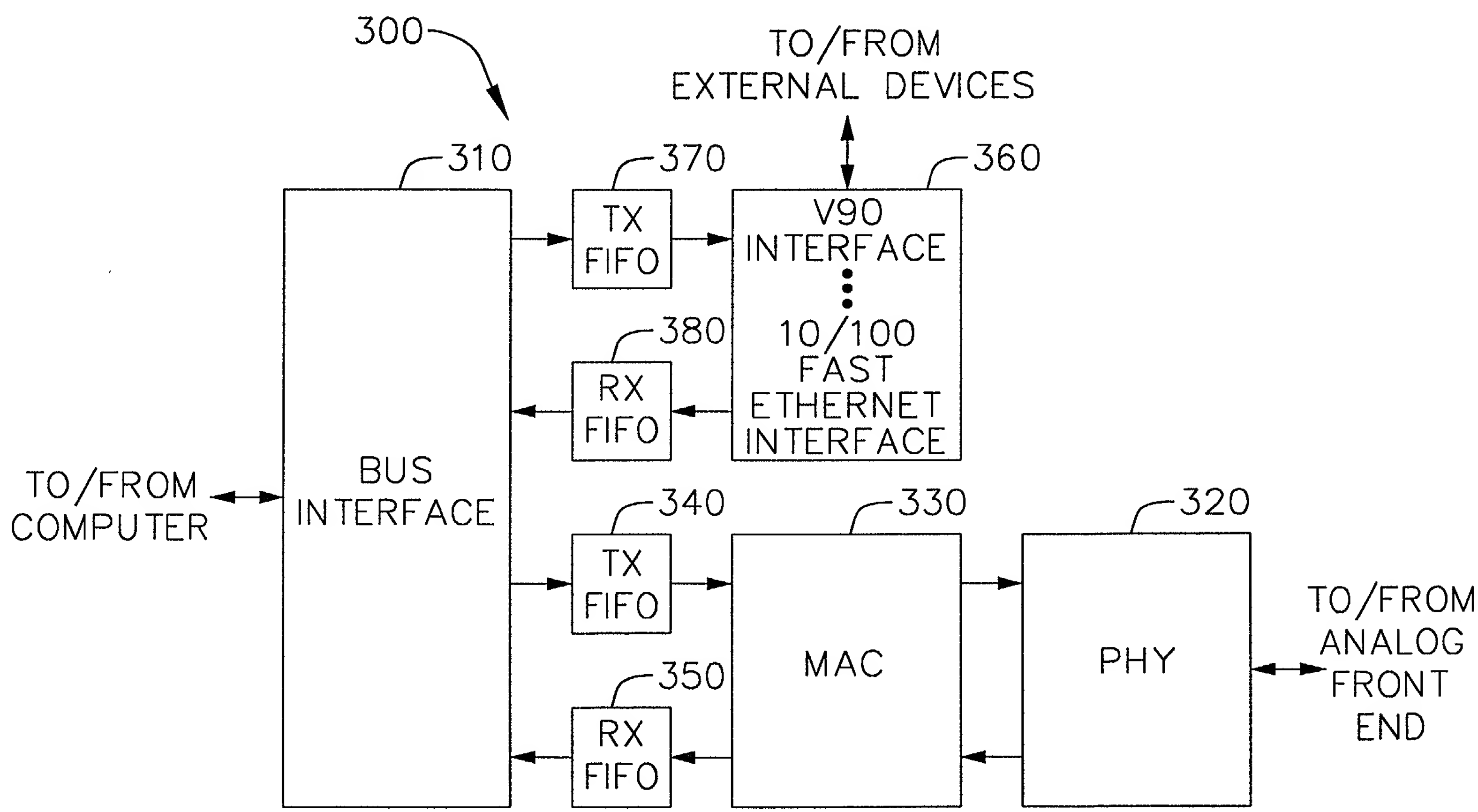
SHARED NETWORK MEDIUM
250
140a
240a
NODE
140b
240b
NODE
140c
240c
NODE

FIG. 3b



140d
260d
NODE
140e
260e
NODE
255
NODE/ HUB
140f
260f
NODE

FIG. 4a



300
310
BUS INTERFACE
TO/FROM COMPUTER
370
TX FIFO
380
RX FIFO
360
V90 INTERFACE
10/100 FAST ETHERNET INTERFACE
TO/FROM EXTERNAL DEVICES
340
TX FIFO
350
RX FIFO
330
MAC
320
PHY
TO/FROM ANALOG FRONT END

FIG. 4b

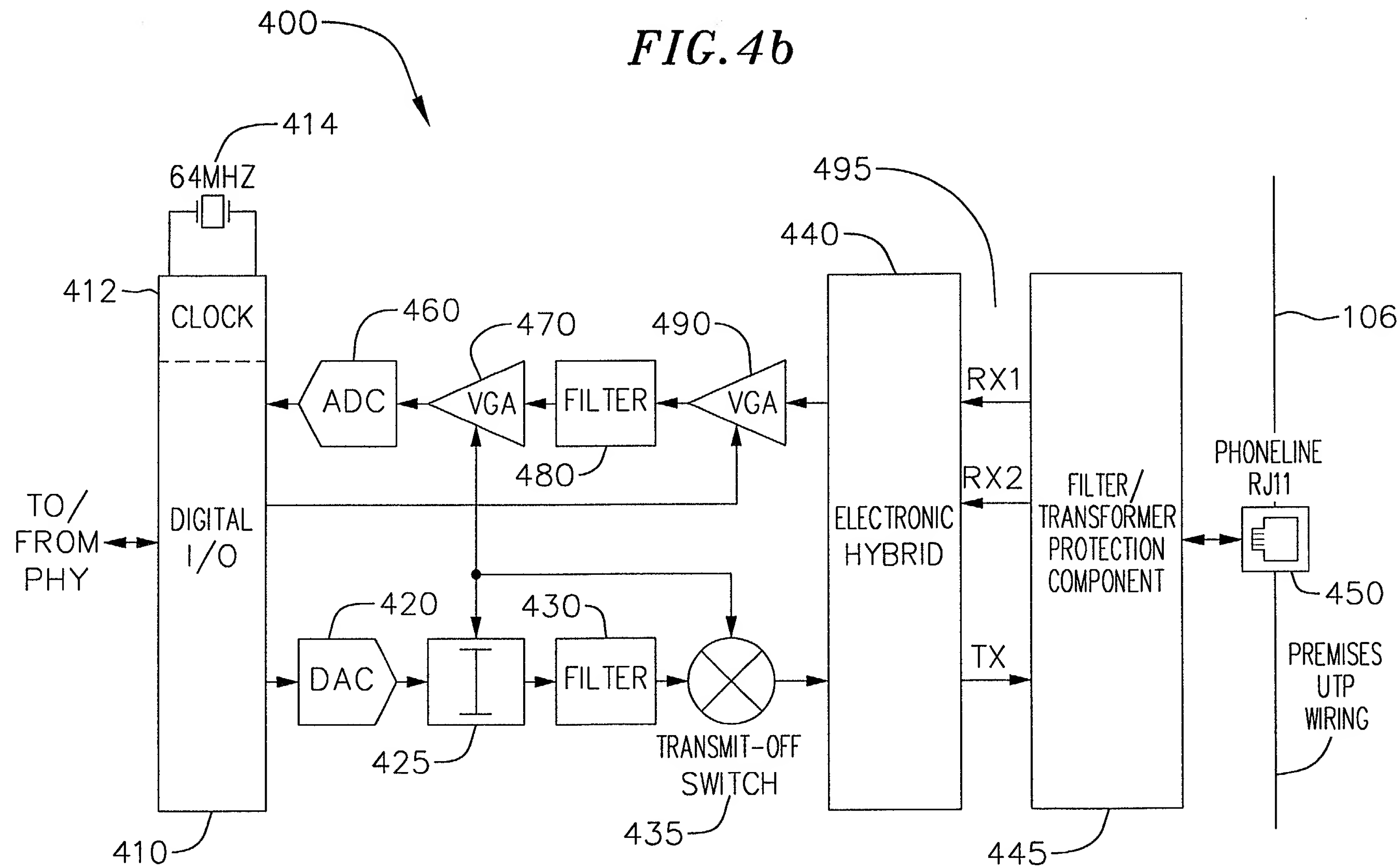

400
414
64MHZ
412
CLOCK
DIGITAL I/O
410
TO/ FROM PHY
460
ADC
470
VGA
480
FILTER
490
VGA
420
DAC
425
430
FILTER
TRANSMIT-OFF SWITCH
435
495
440
ELECTRONIC HYBRID
RX1
RX2
TX
FILTER/ TRANSFORMER PROTECTION COMPONENT
445
PHONELINE RJ11
450
106
PREMISES UTP WIRING

FIG. 5

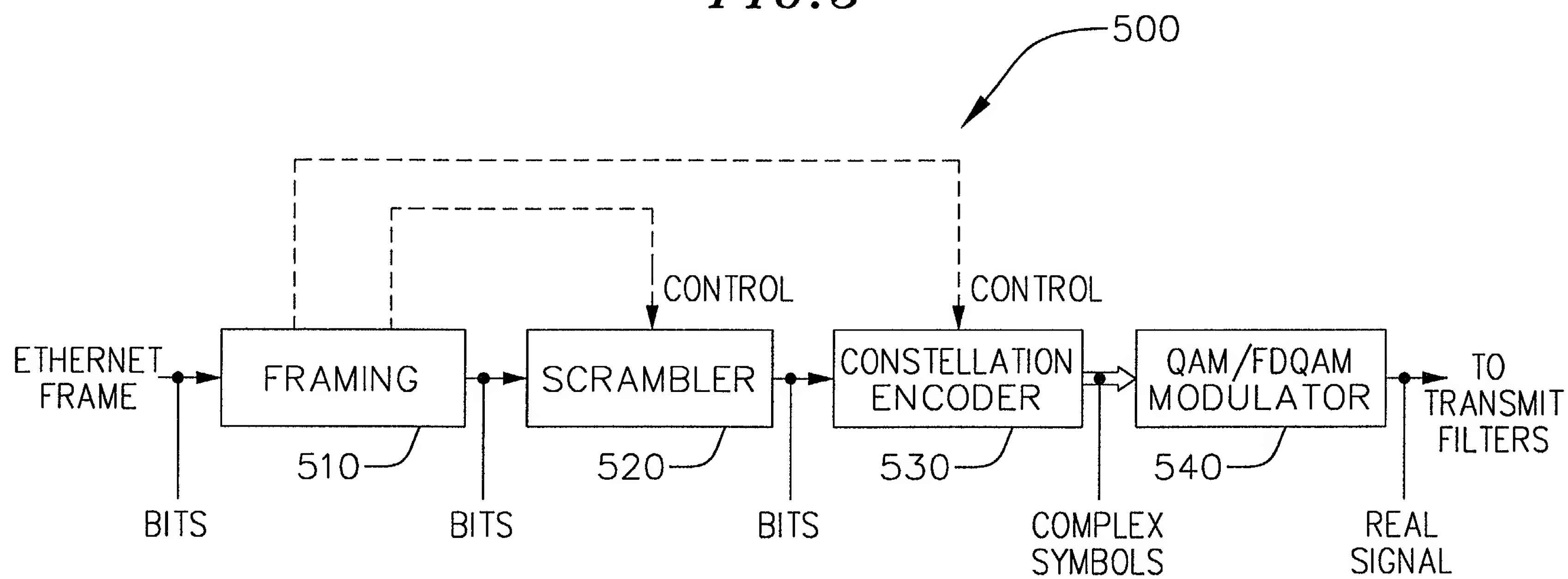

500
CONTROL
CONTROL
ETHERNET FRAME
FRAMING
SCRAMBLER
CONSTELLATION ENCODER
QAM/FDQAM MODULATOR
TO TRANSMIT FILTERS
510
520
530
540
BITS
BITS
BITS
COMPLEX SYMBOLS
REAL SIGNAL

FIG. 6

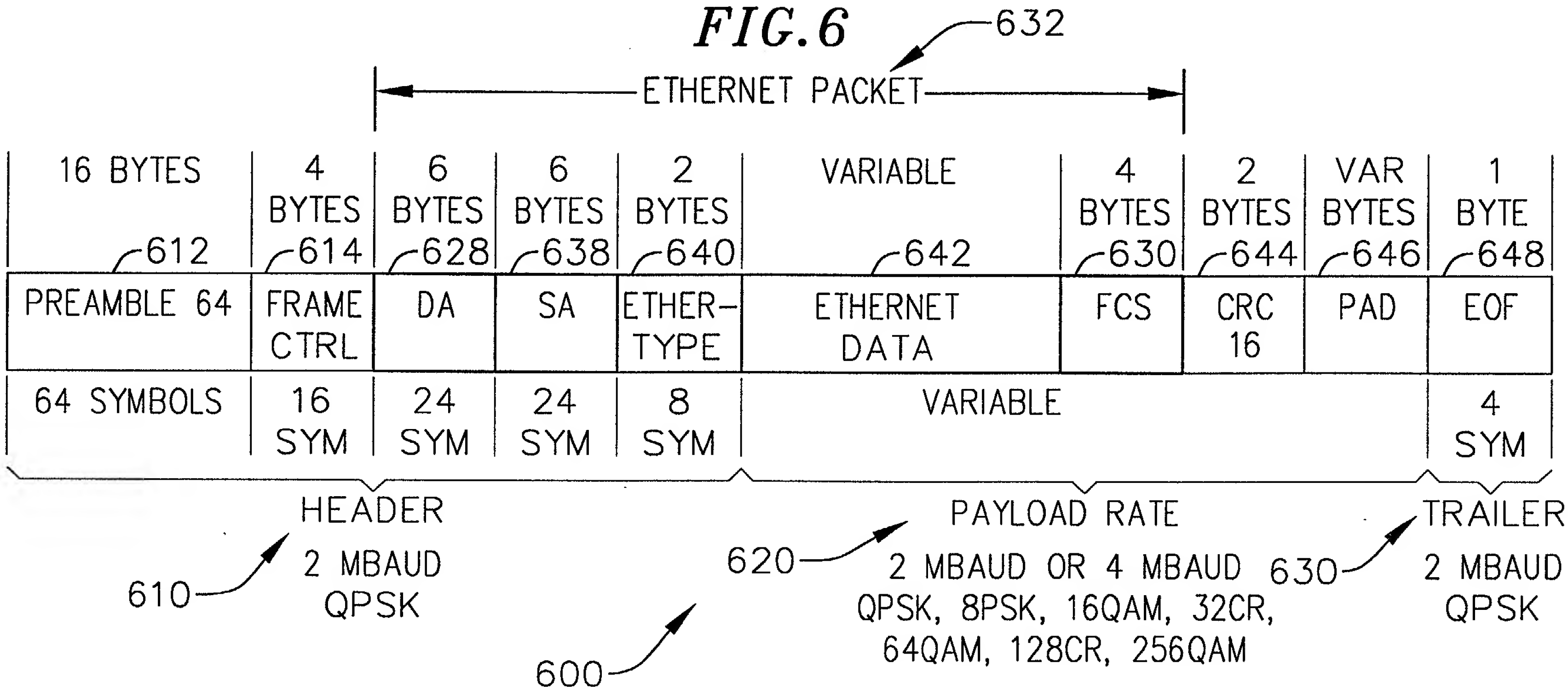

632
ETHERNET PACKET
16 BYTES
612
PREAMBLE 64
64 SYMBOLS
4 BYTES
614
FRAME CTRL
16 SYM
6 BYTES
628
DA
24 SYM
6 BYTES
638
SA
24 SYM
2 BYTES
640
ETHER-TYPE
8 SYM
VARIABLE
642
ETHERNET DATA
VARIABLE
4 BYTES
630
FCS
2 BYTES
644
CRC 16
VAR BYTES
646
PAD
1 BYTE
648
EOF
4 SYM
HEADER
2 MBAUD
QPSK
610
620
PAYLOAD RATE
2 MBAUD OR 4 MBAUD
QPSK, 8PSK, 16QAM, 32CR,
64QAM, 128CR, 256QAM
630
TRAILER
2 MBAUD
QPSK
600

FIG. 8

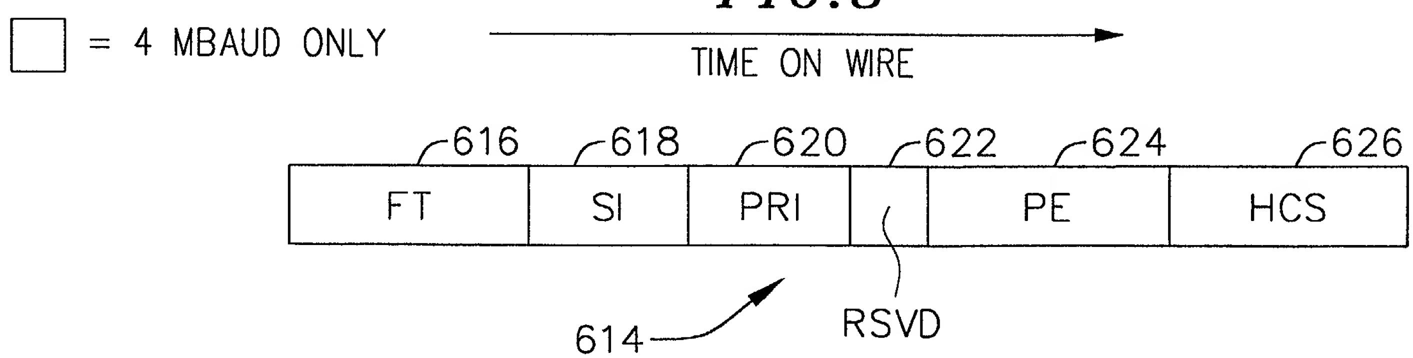

= 4 MBAUD ONLY
TIME ON WIRE
616
FT
618
SI
620
PRI
622
624
PE
626
HCS
RSVD
614

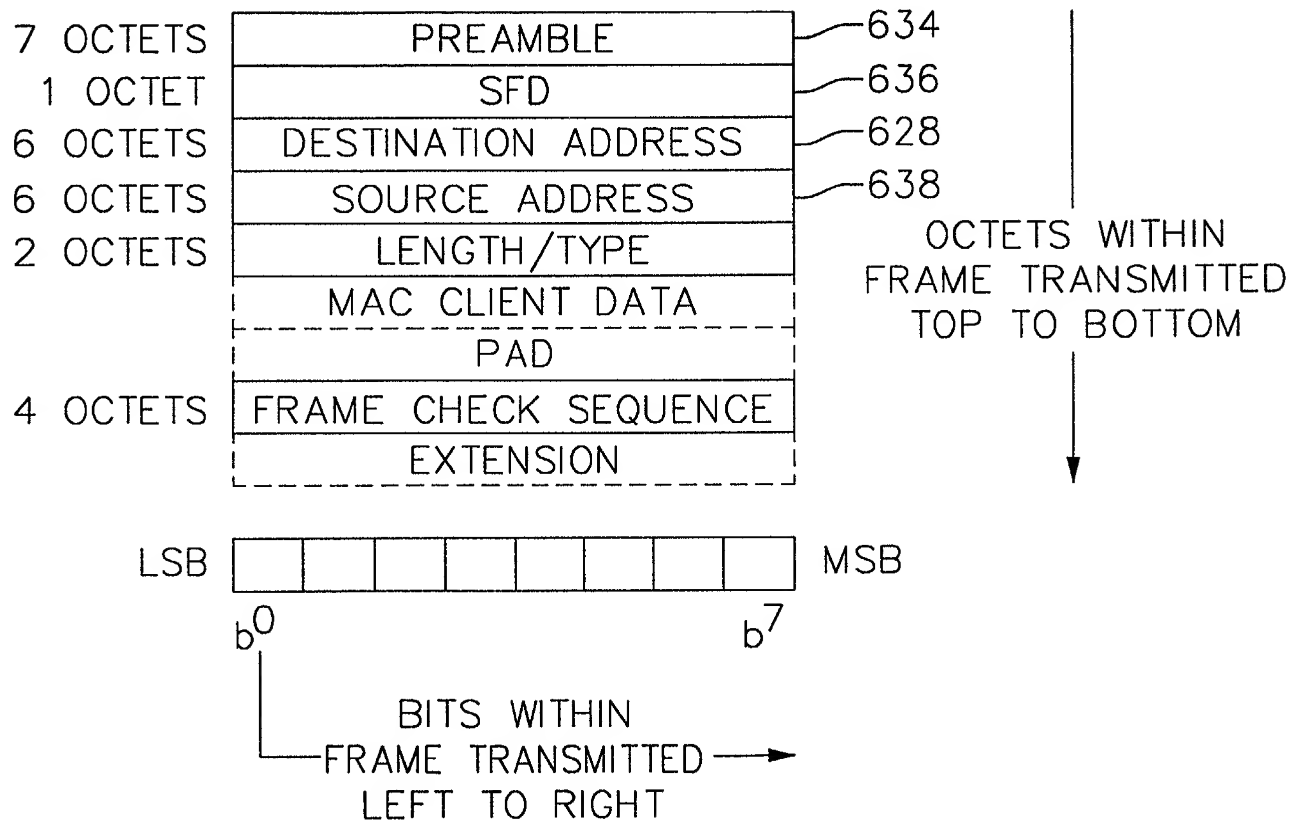
FIG.7

FIELD	BIT NUMBER	BITS	DESCRIPTION
FT	31:24	8	FRAME TYPE. THIS FIELD SHALL BE SET TO ZERO BY THE TRANSMITTER. THE RECEIVER SHALL DECODE THIS FIELD AND DISCARD THE FRAME IF IT'S ANYTHING OTHER THAN ZERO.
RSVD	23	1	RESERVED. THIS FIELD SHALL BE SET TO ZERO BY THE TRANSMITTER, AND THE RECEIVER SHALL IGNORE IT.
PRI	22:20	3	PRIORITY (0–7)
SI	19:16	4	SCRAMBLER INITIALIZATION
PE	15:8	8	PAYLOAD ENCODING
HCS	7:0	8	HEADER CHECK SEQUENCE

FIG. 9

VALUE	INTERPRETATION
0	RESERVED ON TRANSMIT, DISCARD FRAME ON RECEIVE
1	BAUD RATE=2 MHz, 2 BITS PER BAUD
2	BAUD RATE=2 MHz, 3 BITS PER BAUD
3	BAUD RATE=2 MHz, 4 BITS PER BAUD
4	BAUD RATE=2 MHz, 5 BITS PER BAUD
5	BAUD RATE=2 MHz, 6 BITS PER BAUD
6	BAUD RATE=2 MHz, 7 BITS PER BAUD
7	BAUD RATE=2 MHz, 8 BITS PER BAUD
8	RESERVED ON TRANSMIT, DISCARD FRAME ON RECEIVE
9	BAUD RATE=4 MHz, 2 BITS PER BAUD
10	BAUD RATE=4 MHz, 3 BITS PER BAUD
11	BAUD RATE=4 MHz, 4 BITS PER BAUD
12	BAUD RATE=4 MHz, 5 BITS PER BAUD
13	BAUD RATE=4 MHz, 6 BITS PER BAUD
14	BAUD RATE=4 MHz, 7 BITS PER BAUD
15	BAUD RATE=4 MHz, 8 BITS PER BAUD
16–256	RESERVED ON TRANSMIT, DISCARD FRAME ON RECEIVE

FIG. 10


7 OCTETS
1 OCTET
6 OCTETS
6 OCTETS
2 OCTETS
4 OCTETS
PREAMBLE
SFD
DESTINATION ADDRESS
SOURCE ADDRESS
LENGTH/TYPE
MAC CLIENT DATA
PAD
FRAME CHECK SEQUENCE
EXTENSION
634
636
628
638
OCTETS WITHIN
FRAME TRANSMITTED
TOP TO BOTTOM
LSB
MSB
b0
b7
BITS WITHIN
FRAME TRANSMITTED
LEFT TO RIGHT

08/925,501

FIG. 11

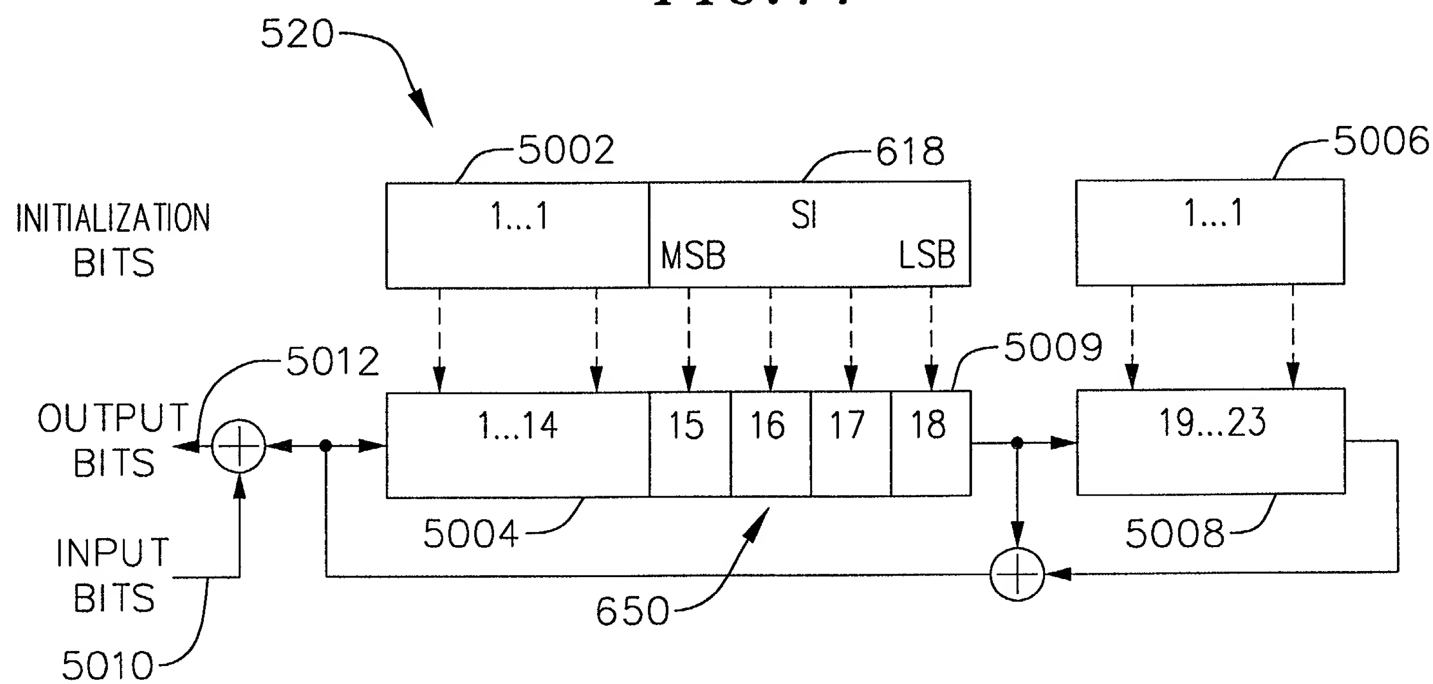


FIG. 12a

2 BITS PER BAUD

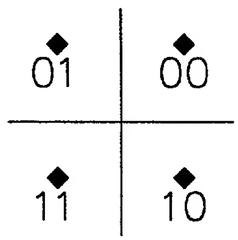


FIG. 12b

3 BITS PER BAUD

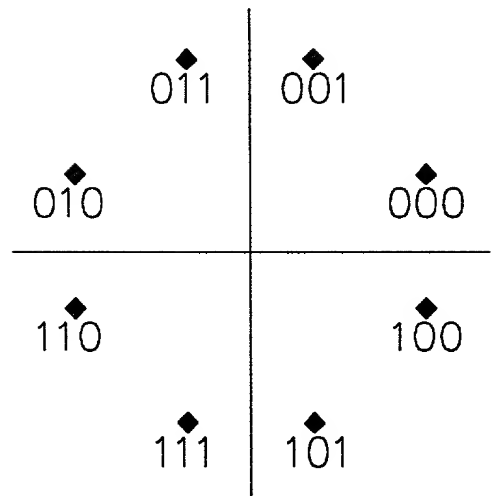


FIG. 12c

4 BITS PER BAUD

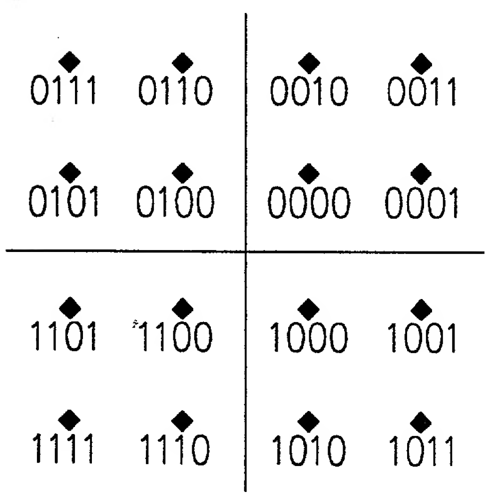


FIG. 12d

5 BITS PER BAUD

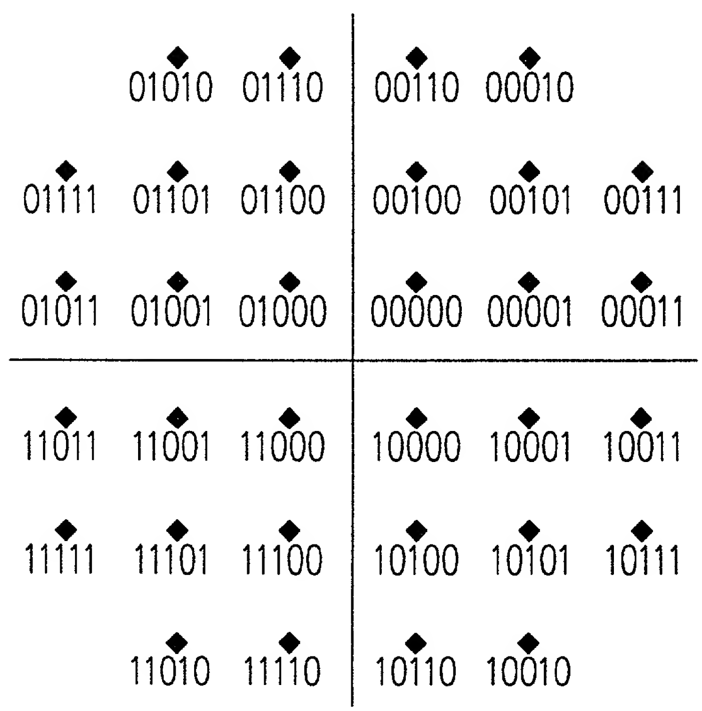


FIG. 12e

6 BITS PER BAUD

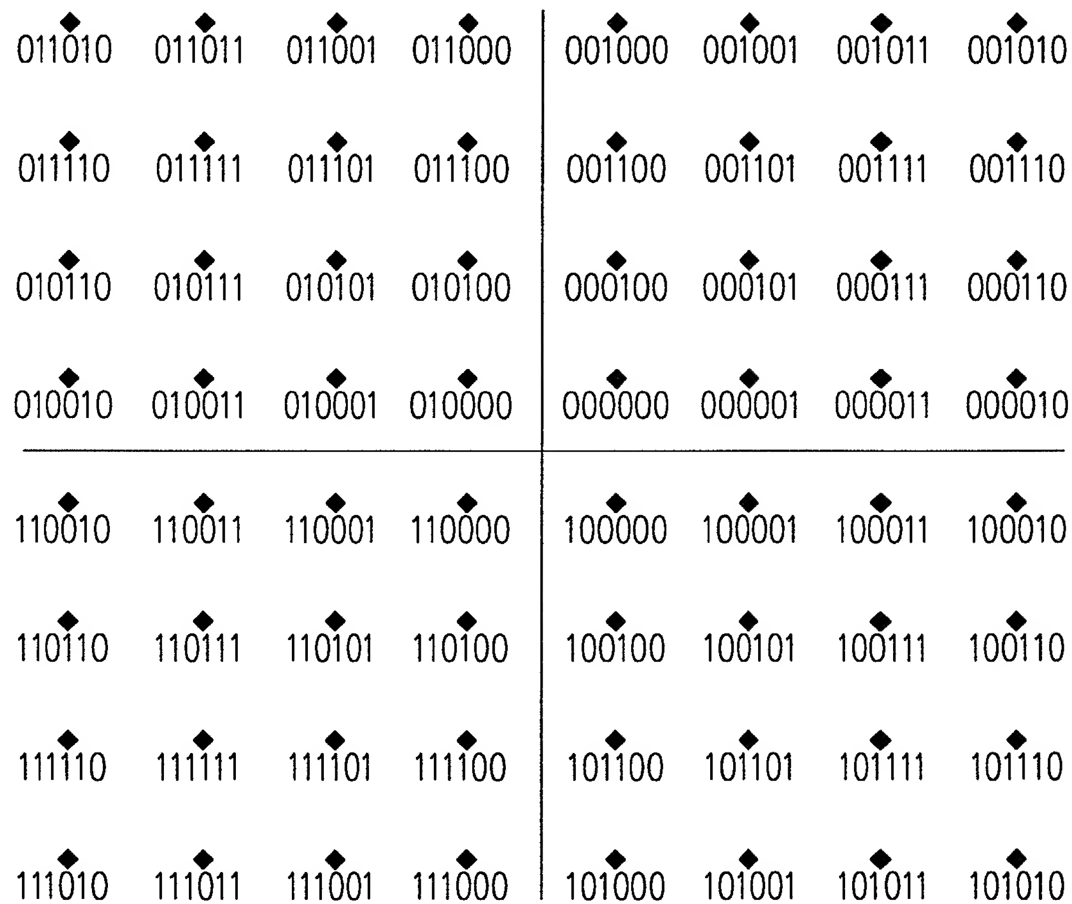


FIG. 12f

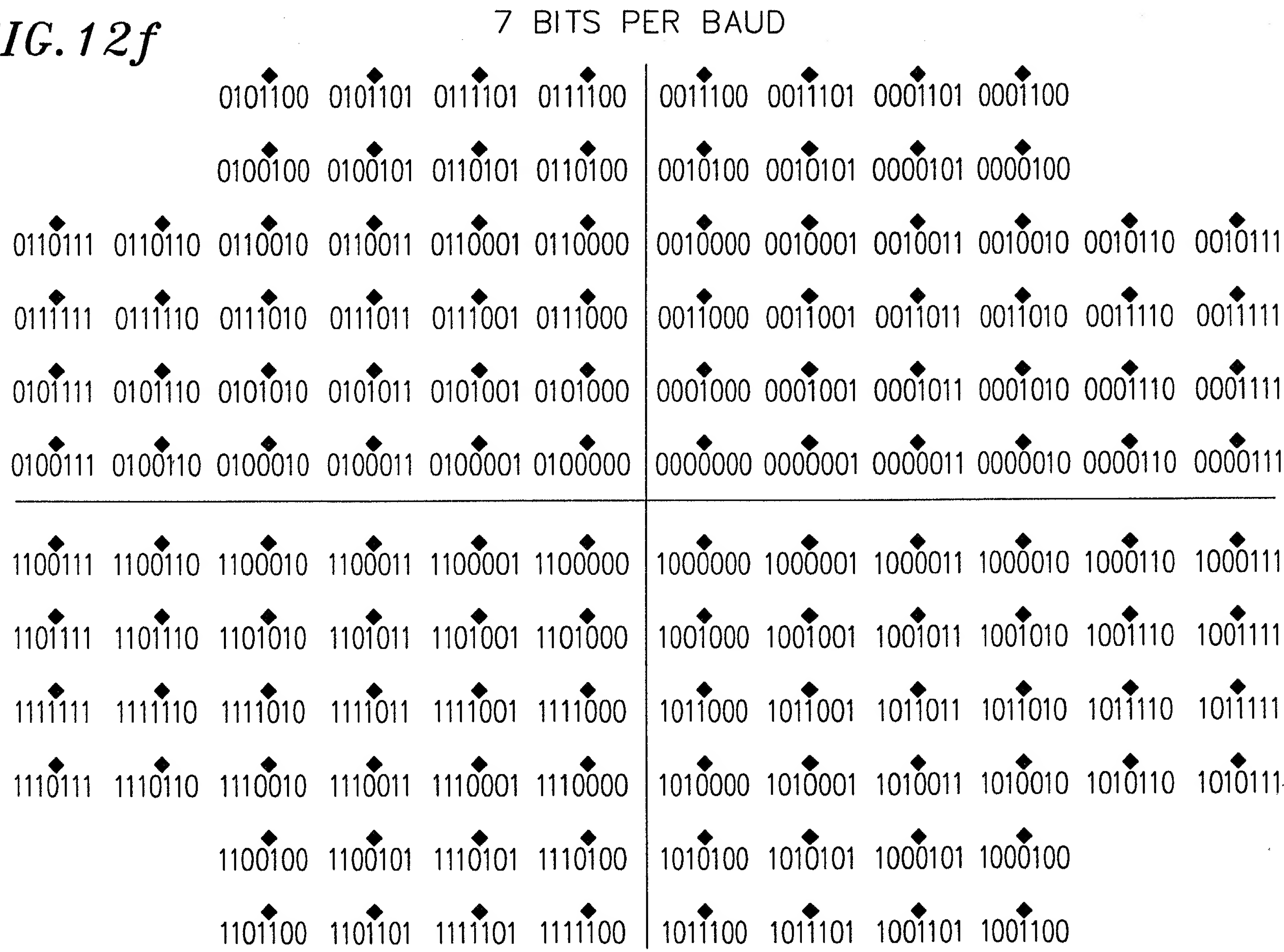

7 BITS PER BAUD
0101100 0101101 0111101 0111100 0011100 0011101 0001101 0001100
0100100 0100101 0110101 0110100 0010100 0010101 0000101 0000100
0110111 0110110 0110010 0110011 0110001 0110000 0010000 0010001 0010011 0010010 0010110 0010111
0111111 0111110 0111010 0111011 0111001 0111000 0011000 0011001 0011011 0011010 0011110 0011111
0101111 0101110 0101010 0101011 0101001 0101000 0001000 0001001 0001011 0001010 0001110 0001111
0100111 0100110 0100010 0100011 0100001 0100000 0000000 0000001 0000011 0000010 0000110 0000111
1100111 1100110 1100010 1100011 1100001 1100000 1000000 1000001 1000011 1000010 1000110 1000111
1101111 1101110 1101010 1101011 1101001 1101000 1001000 1001001 1001011 1001010 1001110 1001111
1111111 1111110 1111010 1111011 1111001 1111000 1011000 1011001 1011011 1011010 1011110 1011111
1110111 1110110 1110010 1110011 1110001 1110000 1010000 1010001 1010011 1010010 1010110 1010111
1100100 1100101 1110101 1110100 1010100 1010101 1000101 1000100
1101100 1101101 1111101 1111100 1011100 1011101 1001101 1001100

FIG.12g

8 BITS PER BAUD

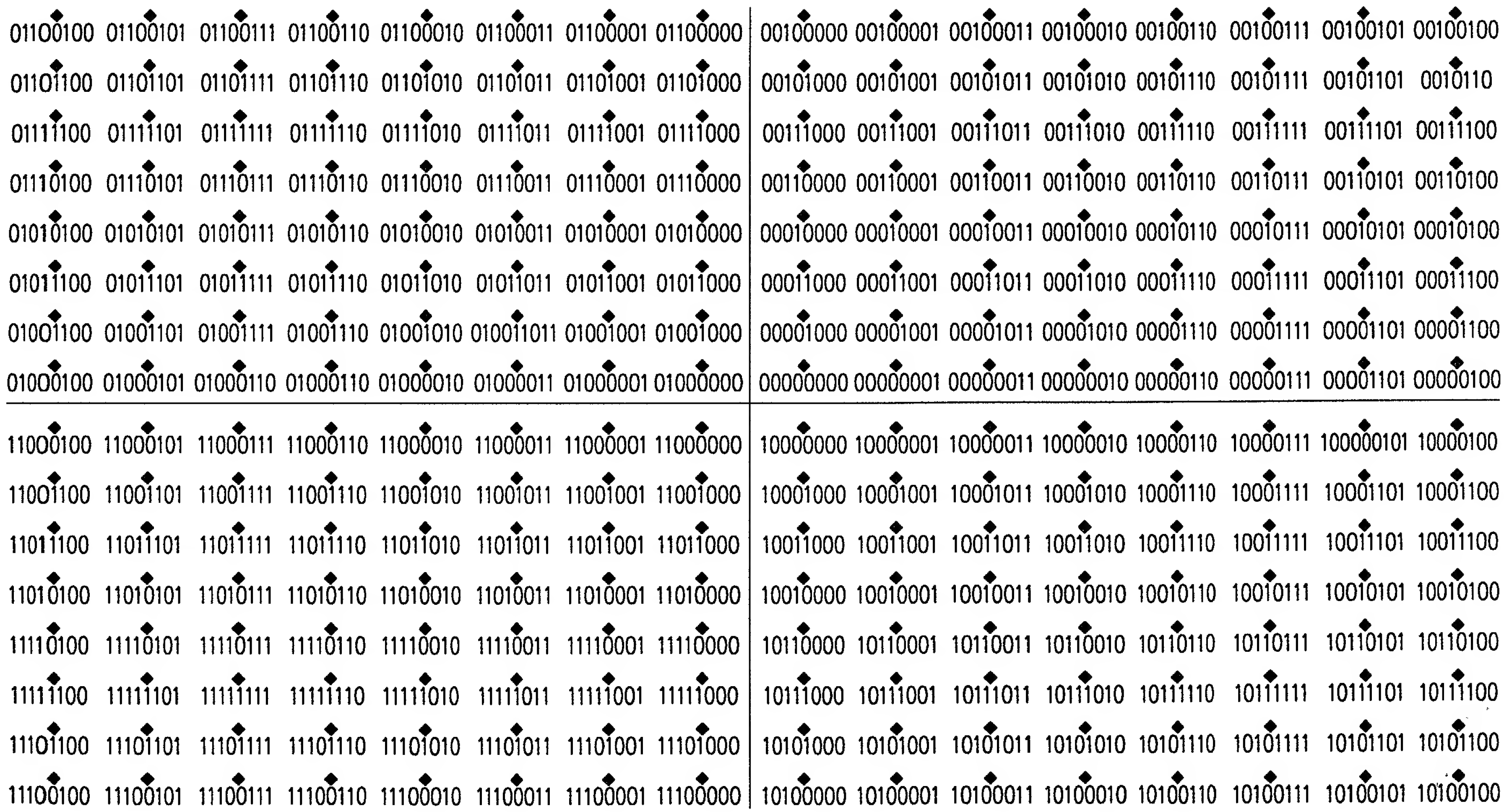


FIG. 13

BITS PER BAUD	REFERENCE POINT(S)	VALUE
2	00	1+i
3	000 001	(12+5i)/9 (5+12i)/9
4	0000	(1+i)/3
5	00000	(1+i)/4
6	000000	(1+i)/7
7	0000000	(1+i)/9
8	00000000	(1+i)/15

FIG. 14

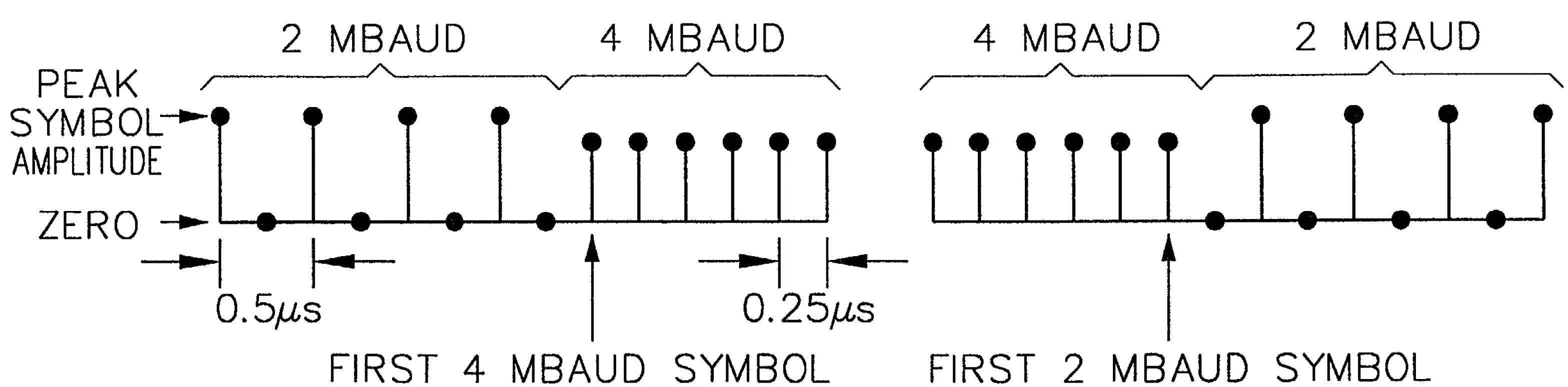


FIG. 15

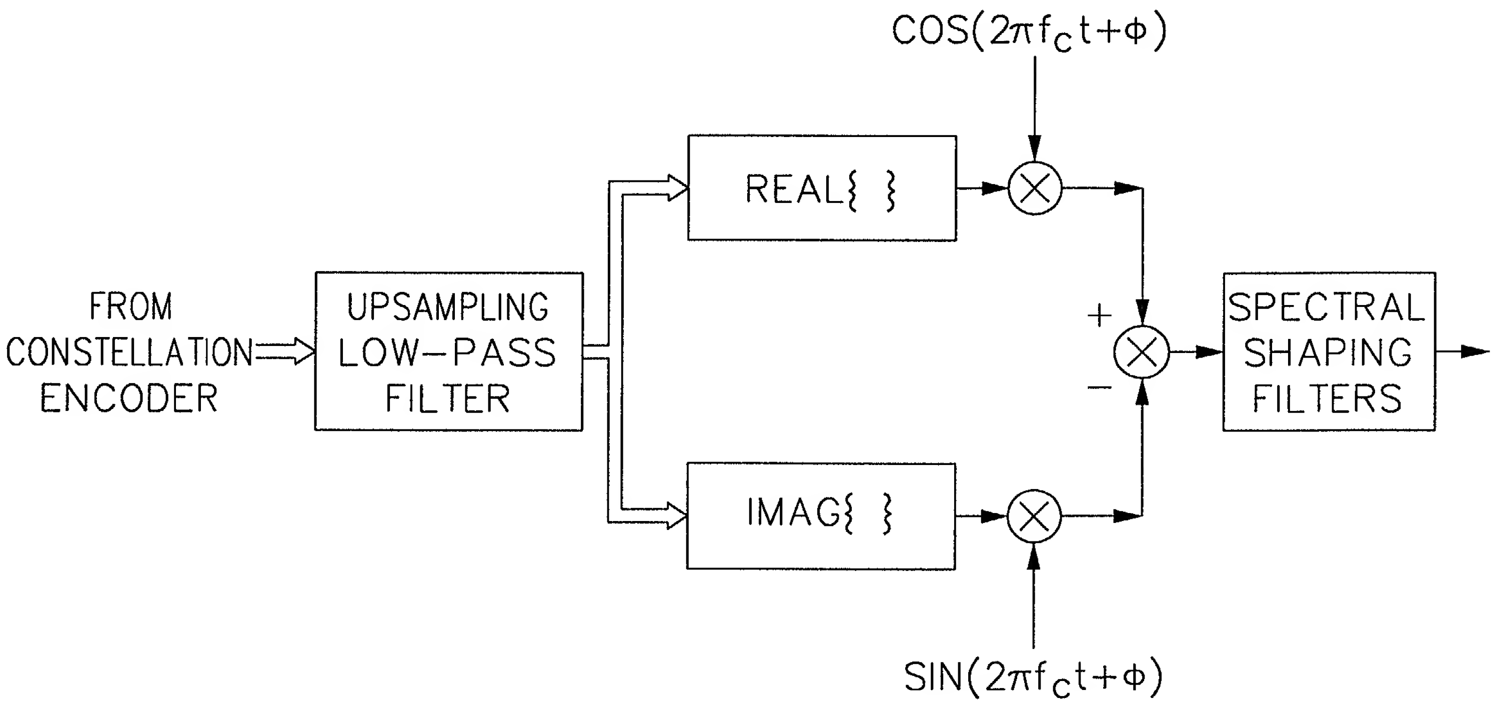
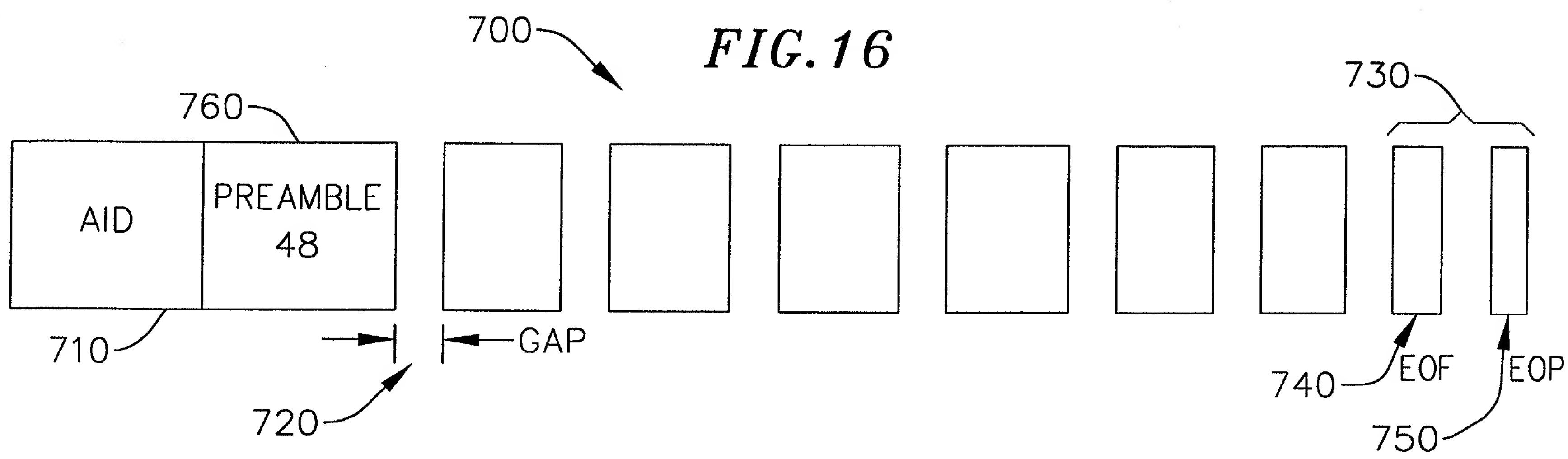
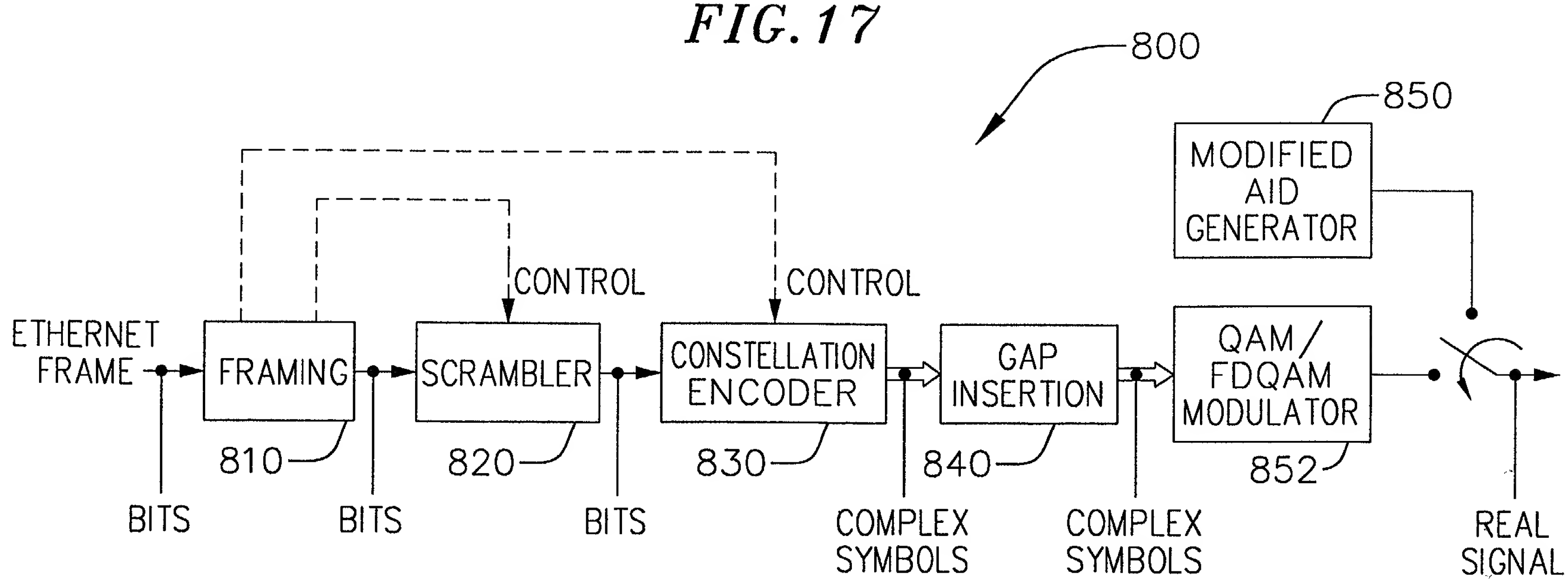

FROM
CONSTELLATION
ENCODER
UPSAMPLING
LOW-PASS
FILTER
REAL{ }
IMAG{ }
COS(2πf$_c$t+φ)
SIN(2πf$_c$t+φ)
+
−
SPECTRAL
SHAPING
FILTERS

FIG. 16



700
760
AID
PREAMBLE
48
710
GAP
720
730
740
EOF
EOP
750

FIG. 17



800
850
MODIFIED
AID
GENERATOR
CONTROL
CONTROL
ETHERNET
FRAME
FRAMING
SCRAMBLER
CONSTELLATION
ENCODER
GAP
INSERTION
QAM/
FDQAM
MODULATOR
810
820
830
840
852
BITS
BITS
BITS
COMPLEX
SYMBOLS
COMPLEX
SYMBOLS
REAL
SIGNAL

FIG. 18

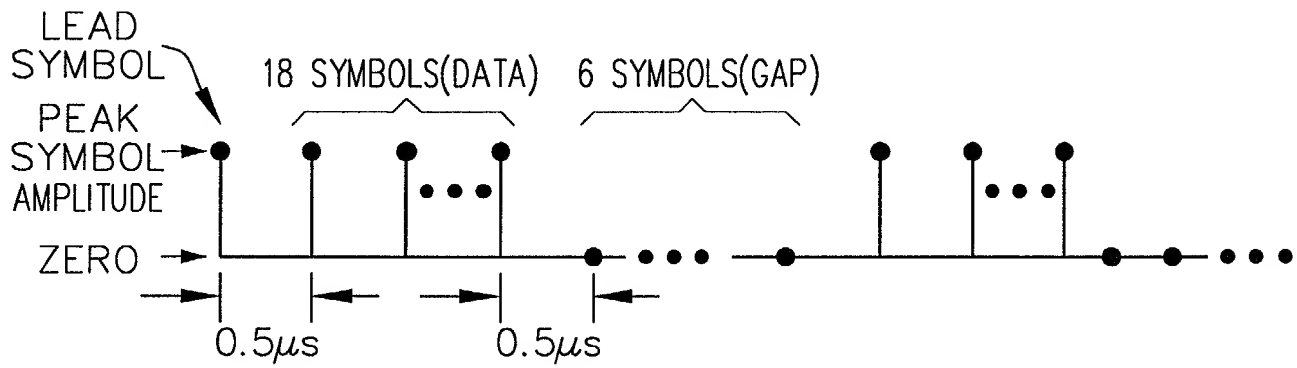

LEAD SYMBOL
PEAK SYMBOL AMPLITUDE
ZERO
18 SYMBOLS(DATA)
6 SYMBOLS(GAP)
0.5μs
0.5μs

FIG. 19

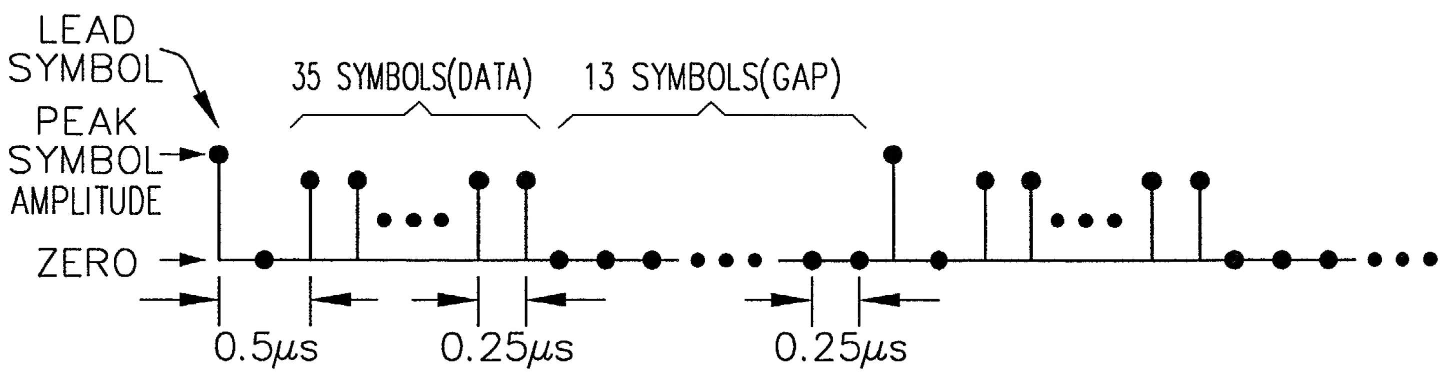

LEAD SYMBOL
PEAK SYMBOL AMPLITUDE
ZERO
35 SYMBOLS(DATA)
13 SYMBOLS(GAP)
0.5μs
0.25μs
0.25μs

FIG.20

M MODULO 2	P MODULO 2	EOF/EOP SEQUENCE
0	0	•4 SYMBOLS, DEFINED BY THE BITS 0xfc •12 ZERO SYMBOLS •1 SYMBOL, DEFINED BY THE BITS 00
0	1	•4 SYMBOLS, DEFINED BY THE BITS 0x03 •12 ZERO SYMBOLS •1 SYMBOL, DEFINED BY THE BITS 11
1	0	•4 SYMBOLS, DEFINED BY THE BITS 0x03 •12 ZERO SYMBOLS •1 SYMBOL, DEFINED BY THE BITS 11
1	1	•4 SYMBOLS, DEFINED BY THE BITS 0xfc •12 ZERO SYMBOLS •1 SYMBOL, DEFINED BY THE BITS 00

FIG.21

M MODULO 2	P MODULO 4	EOF/EOP SEQUENCE
0	0	•4 SYMBOLS, DEFINED BY THE BITS 0xfc •12 ZERO SYMBOLS •1 SYMBOL, DEFINED BY THE BITS 00
0	1	•4 SYMBOLS, DEFINED BY THE BITS 0x56 •12 ZERO SYMBOLS •1 SYMBOL, DEFINED BY THE BITS 10
0	2	•4 SYMBOLS, DEFINED BY THE BITS 0x03 •12 ZERO SYMBOLS •1 SYMBOL, DEFINED BY THE BITS 11
0	3	•4 SYMBOLS, DEFINED BY THE BITS 0xa9 •12 ZERO SYMBOLS •1 SYMBOL, DEFINED BY THE BITS 01
1	0	•4 SYMBOLS, DEFINED BY THE BITS 0x03 •12 ZERO SYMBOLS •1 SYMBOL, DEFINED BY THE BITS 11
1	1	•4 SYMBOLS, DEFINED BY THE BITS 0xa9 •12 ZERO SYMBOLS •1 SYMBOL, DEFINED BY THE BITS 01
1	2	•4 SYMBOLS, DEFINED BY THE BITS 0xfc •12 ZERO SYMBOLS •1 SYMBOL, DEFINED BY THE BITS 00
1	3	•4 SYMBOLS, DEFINED BY THE BITS 0x56 •12 ZERO SYMBOLS •1 SYMBOL, DEFINED BY THE BITS 10

10974956.020701

FIG.22

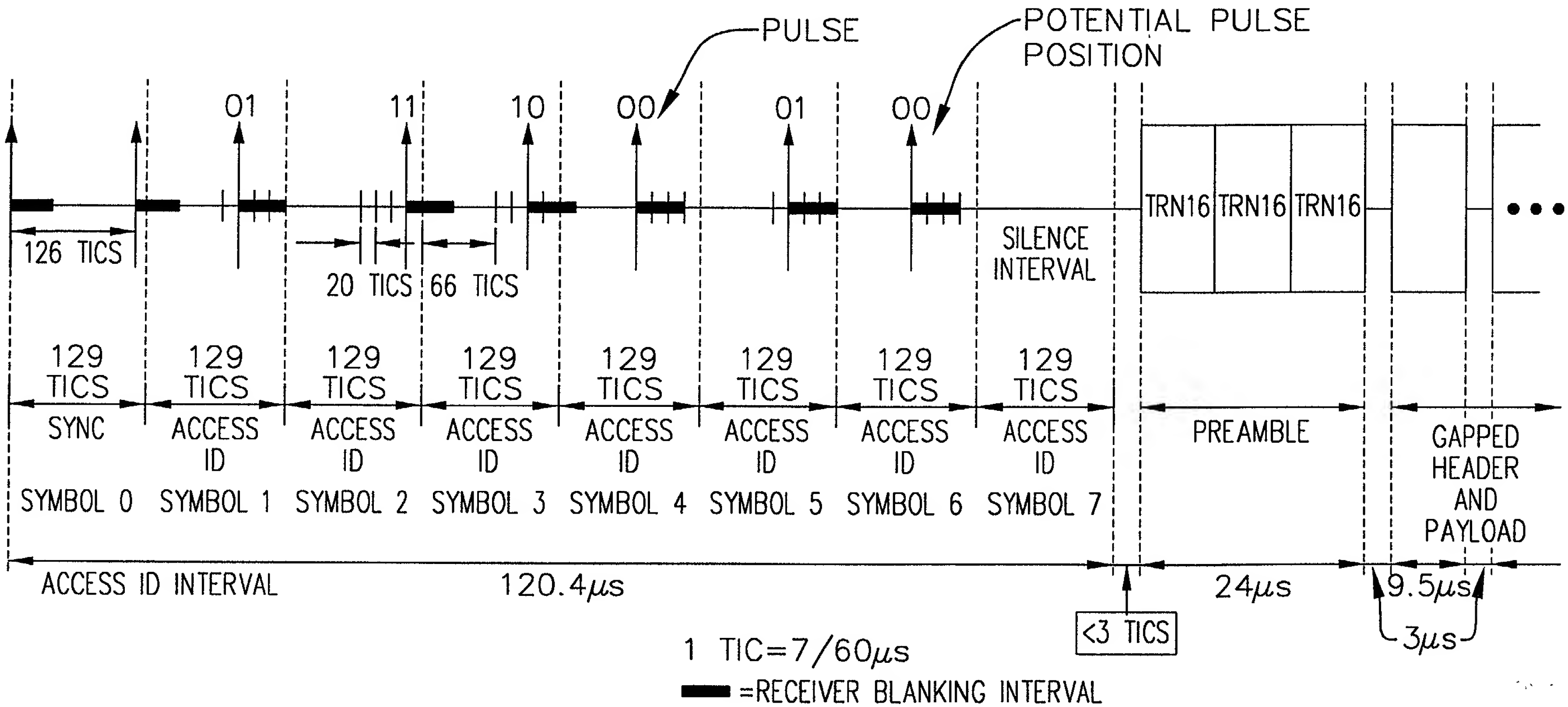


FIG.23a

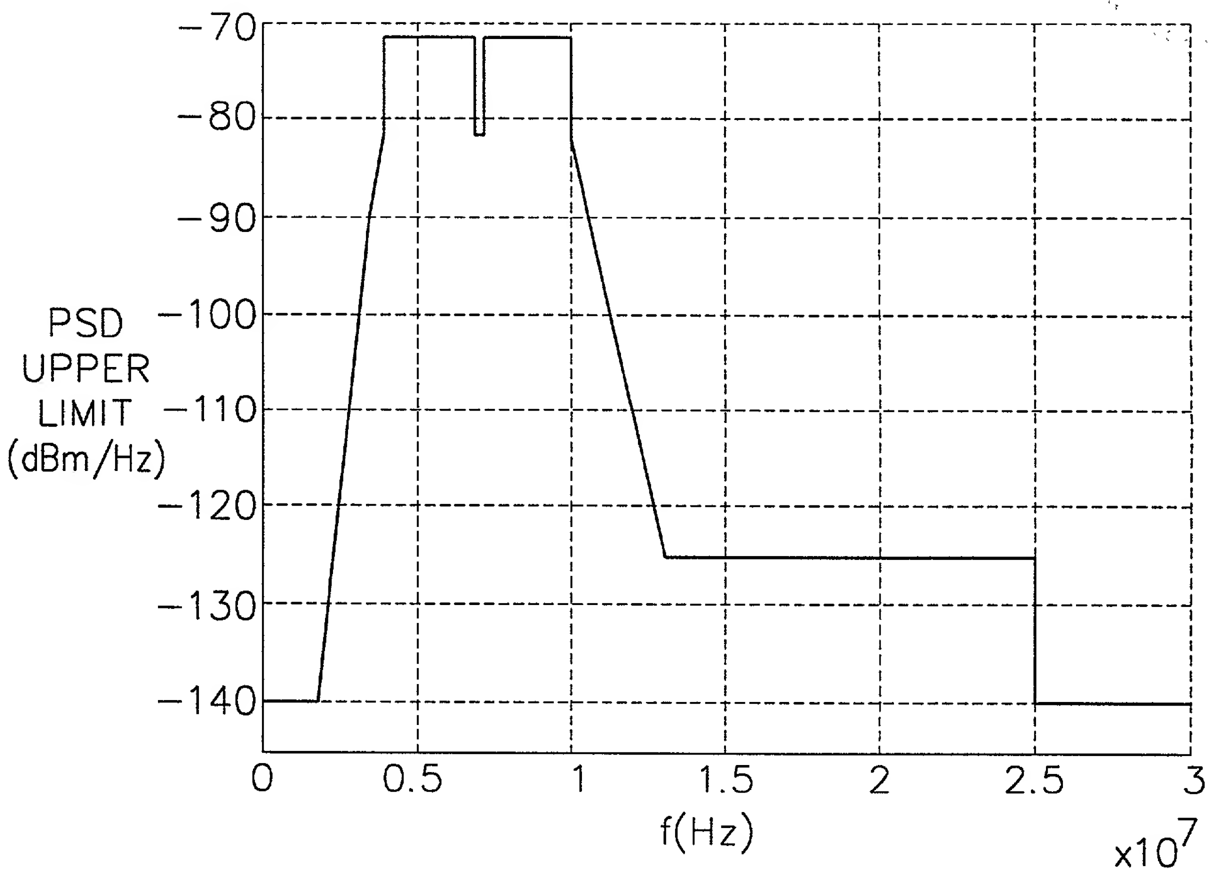


FIG.23b

FREQUENCY(MHz)	PSD LIMIT(dBm/Hz)
0.015<f<=1.7	−140
1.7<f<=3.5	−140+(f−1.7)*50.0/1.8
3.5<f<=4.0	−90+(f−3.5)*17.0
4.0<f<=7.0	−71.5
7.0<f<=7.3	−81.5
7.3<f<=10.0	−71.5
10.0<f<=13.0	−81.5−(f−10.0)*43.5/3.0
13.0<f<=25.0	−125
25.0<f<=30.0	−140

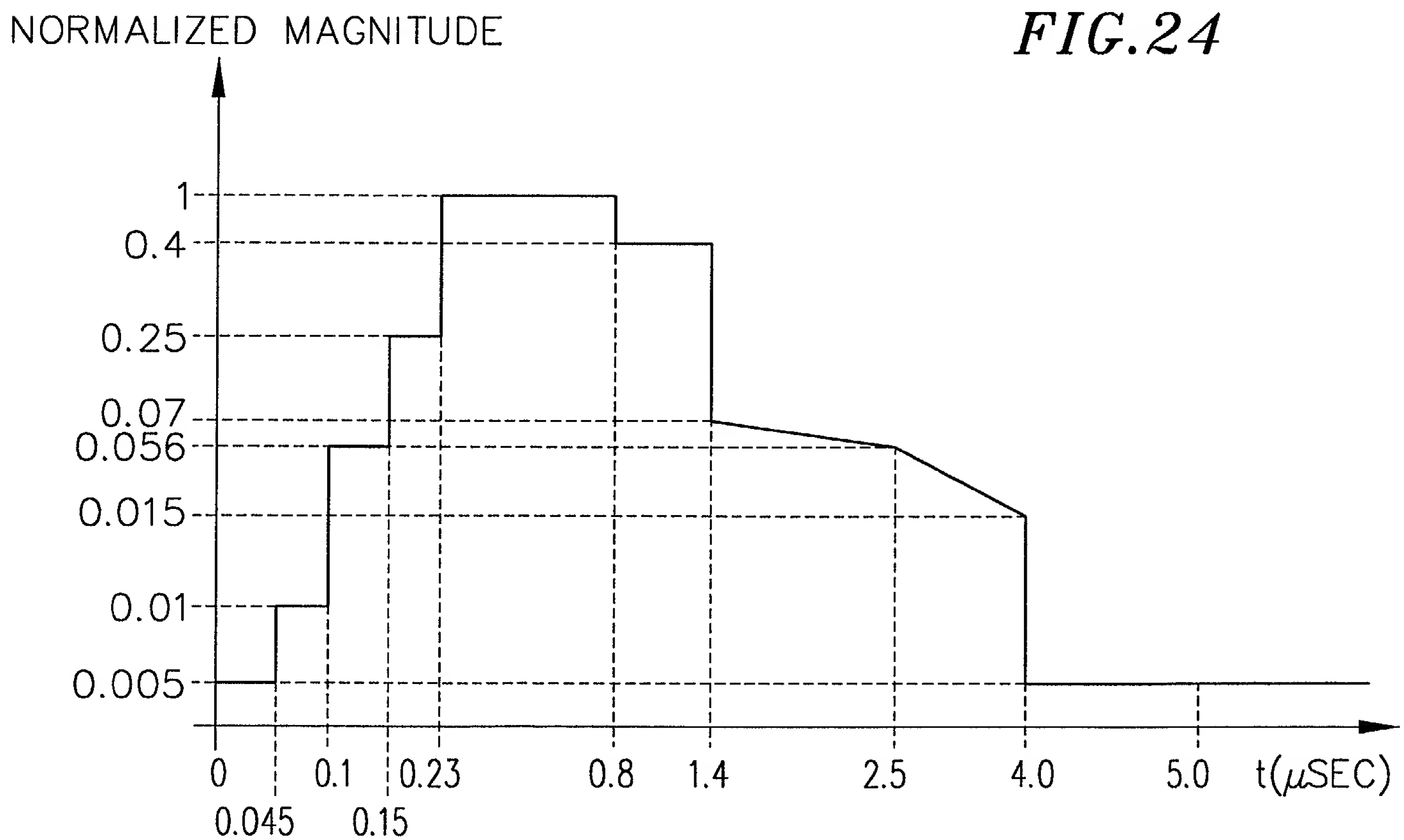

NORMALIZED MAGNITUDE
1
0.4
0.25
0.07
0.056
0.015
0.01
0.005
0
0.045
0.1
0.15
0.23
0.8
1.4
2.5
4.0
5.0
t(μSEC)

FIG.24

FIG.25

FREQUENCY RANGE(MHz)	MAXIMUM·PEAK–TO–PEAKINTERFERER LEVEL(VOLTS)
0.01–0.1	6.0
0.1–0.6	3.3
0.6–1.7	1.0
1.7–4.0	0.1
7.0–7.3	0.1
10.0–10.15	0.1
14.0–14.35	0.28
18.068–18.168	0.5
21.0–21.45	0.5
24.89–24.99	0.5
28.0–29.7	0.5

FIG.26

FREQUENCY RANGE(MHz)	MAXIMUM PEAK–TO–PEAKINTERFERER LEVEL(VOLTS)
0.01–0.1	20.0
0.1–0.6	20.0
0.6–1.7	10.0
1.7–4.0	2.5
7.0–7.3	2.5
10.0–10.15	2.5
14.0–14.35	5.0
18.068–18.168	5.0
21.0–21.45	5.0
24.89–24.99	5.0
28.0–29.7	5.0

FIG.27

FREQUENCY RANGE(kHz)	MIN.IMPEDANCE(OHMS)
0<f<=0.285	1 M
0.285<f<=2.85	100 k
2.85<f<=28.5	10 k
28.5<f<=95	4.0 k
95<f<=190	2.0 k
190<f<=285	1.4 k
285<f<=380	1.0 k
380<f<=475	850
475<f<=570	700
570<f<=665	600
665<f<=760	525
760<f<=855	450
855<f<=950	400
950<f<=1000	350
1000<f<=1400	175
1400<f<=2300	100
2300<f<=2850	50
2850<f<=3085	25
3085<f<=3725	10
3725<f<=3935	25
3935<f<=4000	50
10000<f<=10450	40
10450<f<=10925	25
10925<f<=13125	10
13125<f<=14175	25
14175<f<=16800	50
16800<f<=21000	100
21000<f<=30000	50

FIG.28

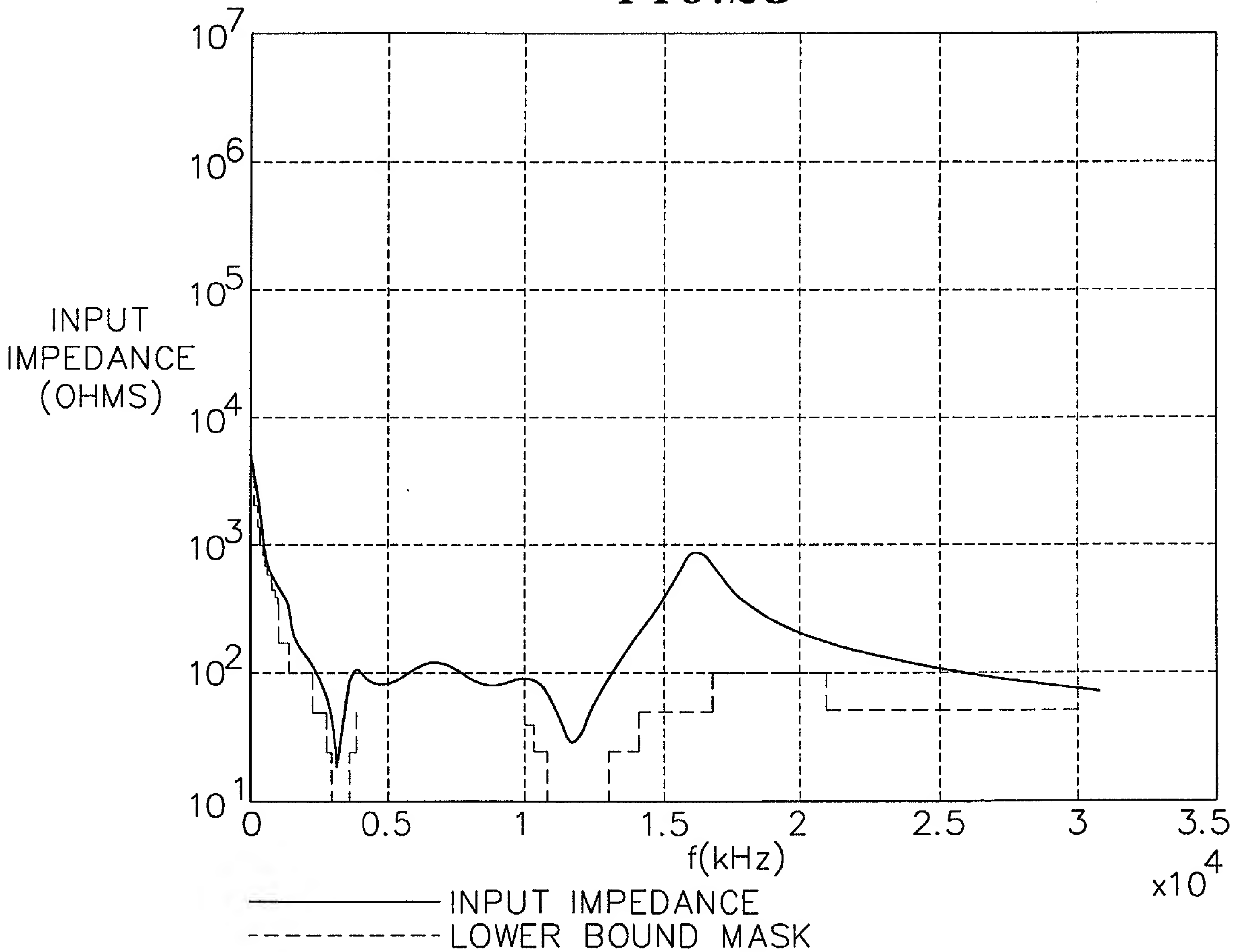
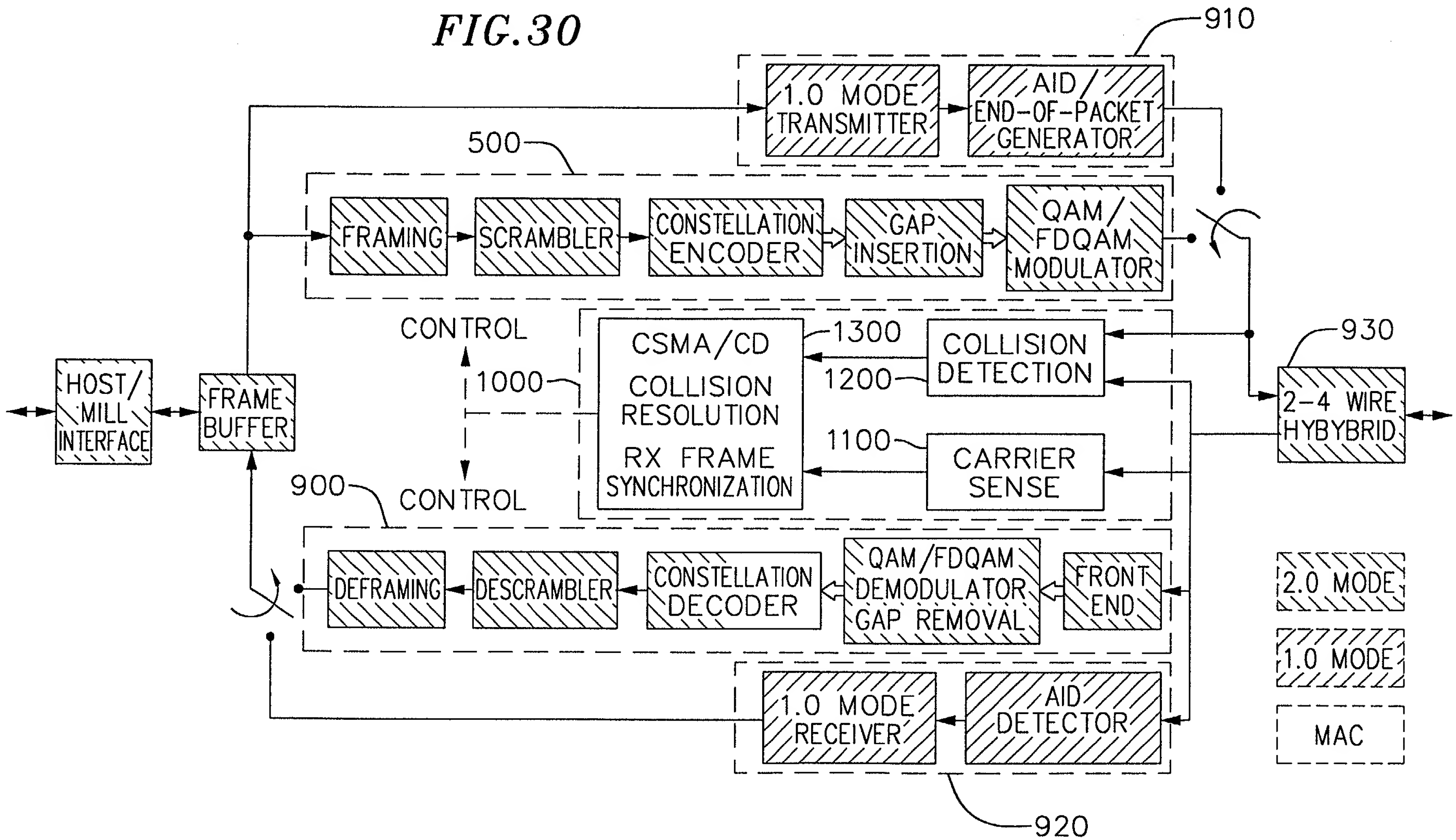

INPUT IMPEDANCE (OHMS)
10^7
10^6
10^5
10^4
10^3
10^2
10^1
0
0.5
1
1.5
2
2.5
3
3.5
f(kHz)
$\times 10^4$
INPUT IMPEDANCE
LOWER BOUND MASK

FIG.29

OSI	IEEE	FUNCTION
DATA LINK	–	LINK LAYER SIGNALING(DRIVER) a) RATE ADAPTATION, QoS AND 1M8 COMPATIBILITY b) LARQ ERROR RECOVERY c) LINK INTEGRITY AND CAPABILITY DISCOVERY
	MAC CONTROLLER LAYER	MAC CONTROLLER LAYER FUNCTIONS a) HOST INTERFACE b) CONTROL AND STATUS REGISTERS, INTERRUPTS c) DMA TRANSFERS, DATA BUFFERING AND COMMAND LIST INTERPRETATION d) PERFORMANCE COUNTERS e) MAC ADDRESS FILTERING, WAKE-ON-LAN PROCESSING
	MII	OPTIONAL MII INTERFACE (IN PHY-ONLY)
	LLC-LOGICAL LINK CONTROL	OPTIONAL LINK LAYER SIGNALING (IN PHY-ONLY) a) RATE ADAPTATION, QoS AND 1M8 COMPATIBILITY b) c) LINK INTEGRITY AND CAPABILITY DISCOVERY
		FRAME PROCESSING (TRANSMIT AND RECEIVE) a) FRAMING (FRAME BOUNDARY DELINEATION AND SYNCHRONIZATION) b) ERROR DETECTION (FCS GENERATION AND CHECK, FRAGMENT DETECTION)
	V2 MAC	MEDIA ACCESS CONTROL (MAC) a) CSMA/CD b) COLLISION RESOLUTION (BACKOFF ALGORITHM)
PHY	PHY	PHYSICAL CODING SUBLAYER a) CODING AND MODULATION, CARRIER SENSE, COLLISION DETECTION

FIG.30



910
1.0 MODE TRANSMITTER
AID/ END-OF-PACKET GENERATOR
500
FRAMING
SCRAMBLER
CONSTELLATION ENCODER
GAP INSERTION
QAM/ FDQAM MODULATOR
CONTROL
1000
CSMA/CD
COLLISION RESOLUTION
RX FRAME SYNCHRONIZATION
1300
1200
COLLISION DETECTION
1100
CARRIER SENSE
930
2-4 WIRE HYBYBRID
HOST/ MILL INTERFACE
FRAME BUFFER
900
CONTROL
DEFRAMING
DESCRAMBLER
CONSTELLATION DECODER
QAM/FDQAM DEMODULATOR GAP REMOVAL
FRONT END
1.0 MODE RECEIVER
AID DETECTOR
920
2.0 MODE
1.0 MODE
MAC

FIG. 31

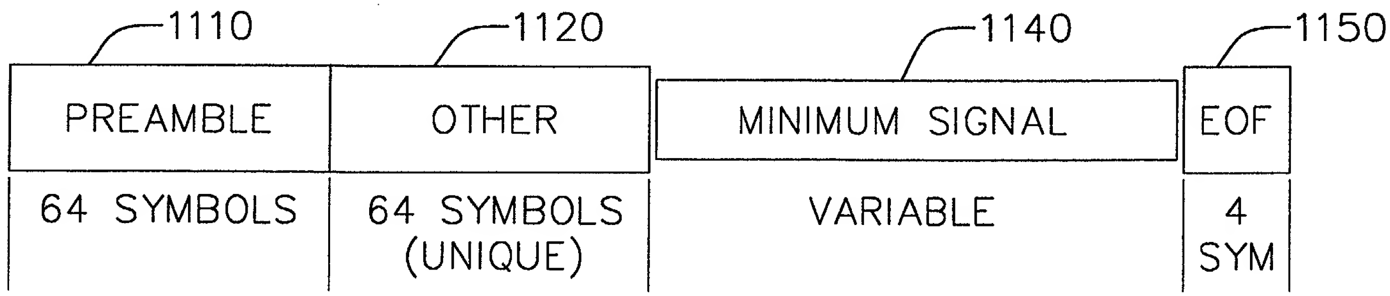


FIG. 32

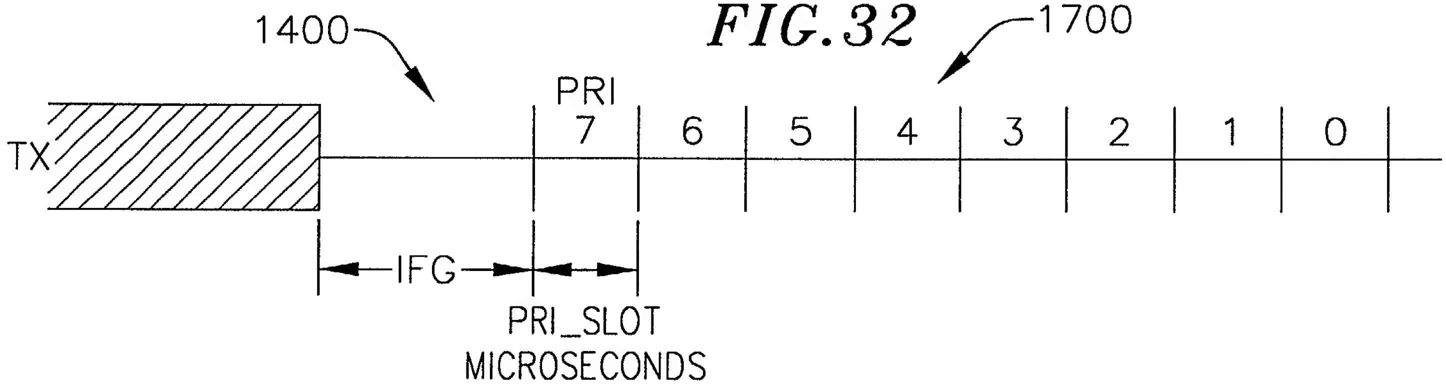


FIG. 33

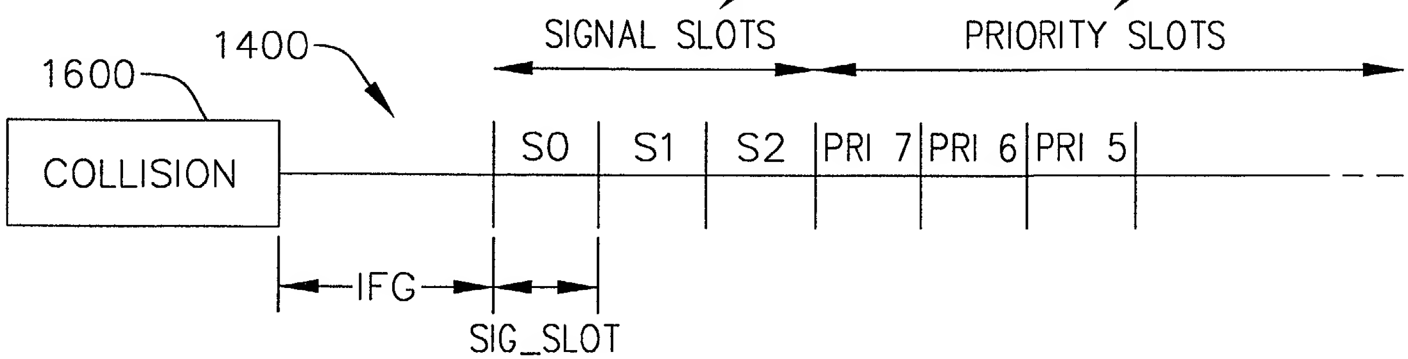


FIG.34a

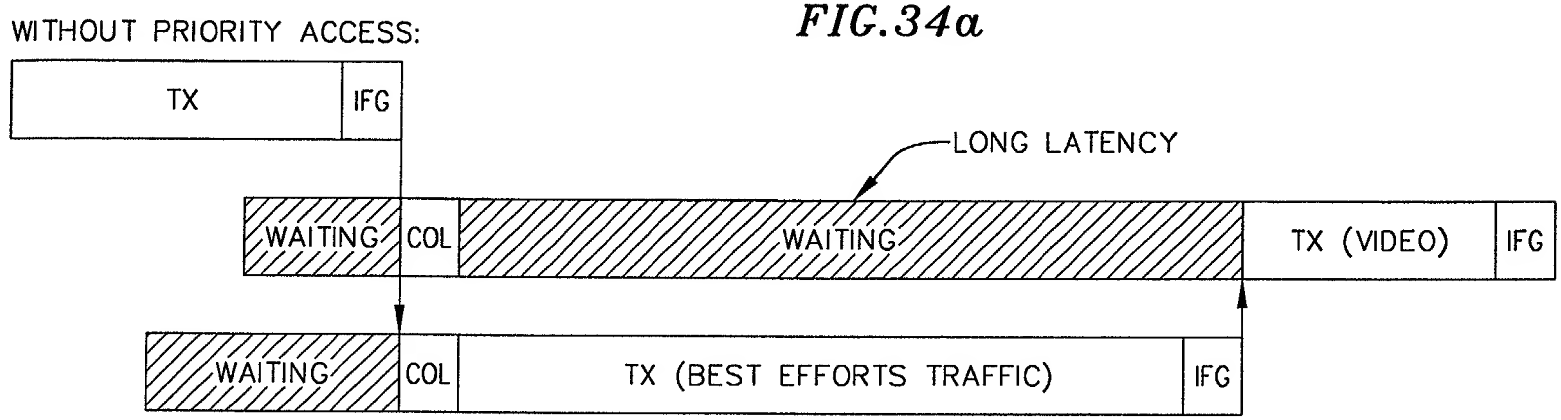


FIG.34b

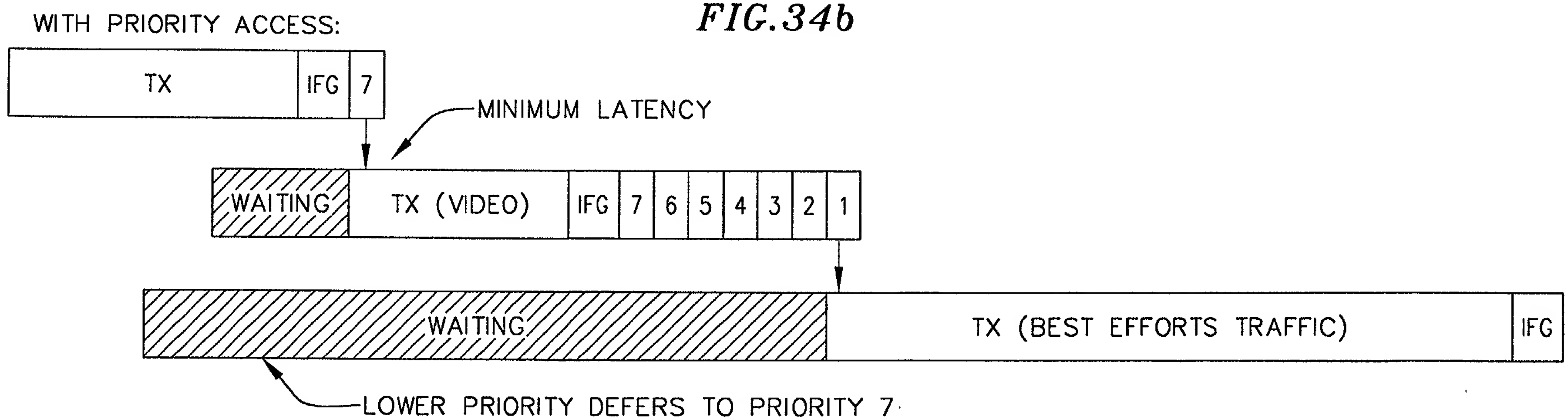
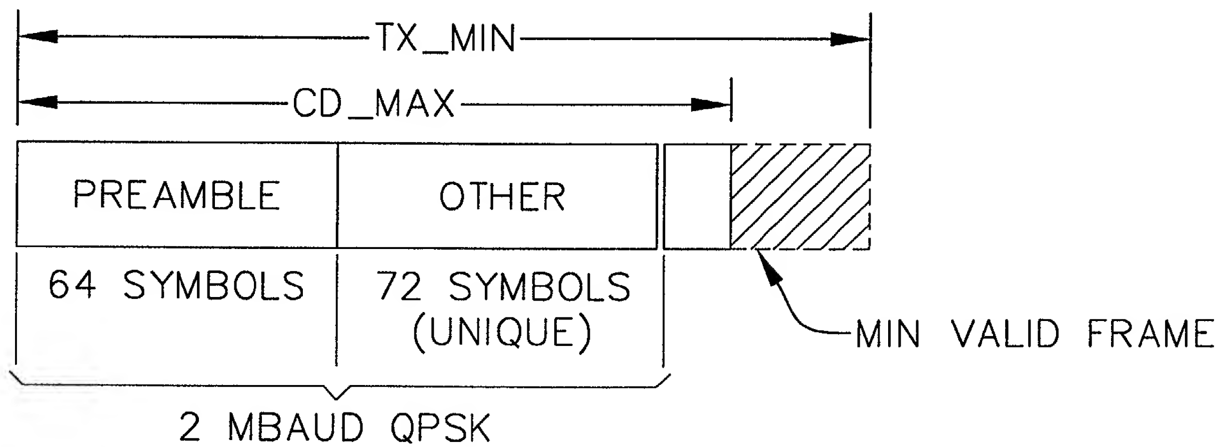


FIG.35



TX_MIN
CD_MAX
PREAMBLE
OTHER
64 SYMBOLS
72 SYMBOLS
(UNIQUE)
MIN VALID FRAME
2 MBAUD QPSK

FIG.36

SECTION	PARAMETER	MIN	MAX	UNITS
BASIC CSMA	NOMINAL_RMS_VOLTAGE	100	–	mVrms
	CS_RANGE	38	–	dB
	CS_IFG	29.0–Δ	29.0+Δ	MICROSECONDS
	CS_DEFER	–	12.0	MICROSECONDS
	MINFRAMESIZE	64	–	OCTETS
	MAXFRAMESIZE	1526	SEE 3.3.7.1	OCTETS
	TX_FRAME	92.5	SEE 3.3.7.1	MICROSECONDS
	TX_ON	0	4.0	MICROSECONDS
PRIORITY ACCESS	PRI_SLOT	21.0–Δ	21.0+Δ	MICROSECONDS
COLLISION DETECTION	CD_FRAG	70.0–Δ	70.0+Δ	MICROSECONDS
	CD_MIN	32.0	–	MICROSECONDS
	CD_THRESHOLD (RECOMMENDED)	–	92.0	MICROSECONDS
	CD_RANGE	36	–	dB
	CD_OFFSET_EARLY	–	12.0	MICROSECONDS
	CD_OFFSET_LATE	–	15.0	MICROSECONDS
COLLISION RESOLUTION	ATTEMPTLIMIT	256	256	
	SIG_SLOT	32.0–Δ	32.0+Δ	MICROSECONDS

FIG.37

FIELD	LENGTH	EXPLANATION
DA	6 OCTETS	DESTINATION ADDRESS
SA	6 OCTETS	SOURCE ADDRESS
ETHERTYPE	2 OCTETS	0x886c (LINK PROTOCOL FRAME. ASSIGNED TO ASSIGNEE BY IEEE)
SSTYPE	1 OCTET	0—RESERVED 1—RATE REQUEST CONTROL FRAME 2—LINK INTEGRITY SHORT FRAME 3—CAPABILITIES ANNOUNCEMENT 4—LARQ 5—VENDOR-SPECIFIC SHORT FORMAT TYPE 6—126 RESERVED 127 RESERVED VALUES 128-255 CORRESPOND TO THE LONG SUBTYPE
SSLENGTH	1 OCTET	NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD (OR THE FIRST OCTET FOLLOWING SSLENGTH IF IT IS NOT DEFINED AS SSVERSION) AND ENDING WITH THE SECOND (LAST) OCTET OF THE NEXT ETHERTYPE FIELD. MIN IS 2 AND MAX IS 225
SSVERSION	1 OCTET	VERSION NUMBER OF THE CONTROL INFORMATION
DATA	0-252 OCTETS	CONTROL INFORMATION
NEXT ETHERTYPE	2 OCTETS	ETHERTYPE/LENGTH OF NEXT LAYER PROTOCOL, 0 IF NONE.
PAD	41-0 OCTETS	PADDING REQUIRED TO MEET MINIMUM IF DATA<41 OCTETS
FCS	4 OCTETS	FRAME CHECK SEQUENCE

FIG.38

FIELD	LENGTH	EXPLANATION
DA	6 OCTETS	DESTINATION ADDRESS
SA	6 OCTETS	SOURCE ADDRESS
ETHERTYPE	2 OCTETS	0x886c (LINK PROTOCOL FRAME. ASSIGNED TO EPIGRAM BY IEEE)
LSTYPE	2 OCTETS	32768 RESERVED 32769 VENDOR-SPECIFIC LONG-FORMAT 32770-65534 RESERVED 65535 RESERVED
LSLENGTH	2 OCTETS	NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD (OR THE FIRST OCTET FOLLOWING SSLENGTH IF IT IS NOT DEFINED AS SSVERSION) AND ENDING WITH THE SECOND (LAST) OCTET OF THE NEXT ETHERTYPE FIELD. MIN IS 2 AND MAX IS 65535.
LSVERSION	1 OCTET	VERSION NUMBER OF THE FOLLOWING PROTOCOL INFORMATION
DATA	LSLENGTH-3 OCTETS	LSTYPE PROTOCOL DEPENDENT DATA
NEXT ETHERTYPE	2 OCTETS	ETHERTYPE/LENGTH OF NEXT LAYER PROTOCOL, 0 IF NONE.
PAD	42-0 OCTETS	PAD TO MINIMUM SIZE IF NEEDED
FCS	4 OCTETS	FRAME CHECK SEQUENCE

FIG.39

FIELD	LENGTH	MEANING
DA	6 OCTETS	DESTINATION ADDRESS
SA	6 OCTETS	SOURCE ADDRESS
ETHERTYPE	2 OCTETS	0x886c (LINK CONTROL FRAME)
SSTYPE	1 OCTET	=1
SSLENGTH	1 OCTET	NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD AND ENDING WITH THE SECOND(LAST) OCTET OF THE NEXT ETHERYPE FIELD. THE MINIMUM VALUE OF SSLENGTH IS 8 FOR SSVERSION 0.
SSVERSION	1 OCTET	=0
OPCODE	1 OCTET	OPERATION CODE FOR THIS CONTROL MESSAGE.
NUMBANDS	1 OCTET	NUMBER OF BANDS SPECIFIED IN THIS CONTROL. EACH BAND HAS A TWO OCTET DESCRIPTOR. THE FIRST BAND REFERS TO 2 MBAUD MODULATION RATE, THE NEXT TO 4 MBAUD. NUMBANDS SHALL BE 1 OR 2 ON TRANSMISSION FOR 10M8 STATIONS, AND STATIONS SHALL IGNORE BAND ENTRIES BEYOND BAND2 ON RECEIVE IF NUMBANDS IS LARGER THAN 2. THE VALUE 0 IS NOT ALLOWED.
NUMADDR	1 OCTET	NUMBER OF ADDRESSES SPECIFIED IN THE PAYLOAD OF THIS CONTROL MESSAGE. NUMADDR MAY BE ZERO. THE SA IN THE ETHERNET HEADER IS ALWAYS USED, AND IS REFERRED TO IN THE FOLLOWING SECTIONS AS REFADDR0.
BAND1_PE	1 OCTET	2MBAUD, 7 MHz CARRIER: THE PE VALUE THAT SHOULD BE USED TO SEND DATA WHEN THE 2MBAUD BAND IS SELECTED. (1..8)ARE THE ONLY VALID VALUES. THE VALUE 8 IS USED TO REQUEST HPNA 1.0 TYPE FRAMES, AND IS VALID ONLY WHEN THE NETWORK IS OPERATING IN V1M2MODE, AND ONLY IN BAND 1.
BAND1_RANK	1 OCTET	THE RANK ORDER OF THE REQDAS' PREFERENCE FOR THIS BAND, 1 IS HIGHEST PREFERENCE, AND THE OTHER BANDS ARE ASSIGNED SUCCESSIVELY LARGER RANK VALUES, NO TWO BANDS SHALL HAVE THE SAME RANK.
BAND2_PE	1 OCTET	OPTIONAL, ONLY PRESENT IF NUMBANDS>=2. 4MBAUD, 7 MHz CARRIER: IF INCLUDED, THIS FIELD IS THE PE VALUE THAT SHOULD BE USED TO SEND DATA WHEN THE 4MBAUD BAND IS SELECTED, (0,9..15) ARE THE ONLY VALID VALUES.
BAND2_RANK	1 OCTET	OPTIONAL, ONLY PRESENT IF NUMBANDS>=2. RANK ORDER OF REQDAS' PREFERENCE FOR THIS BAND.
REFADDR1	6 OCTETS	OPTIONAL. PRESENT IF NUMADDR>=1. THE SECOND MAC ADDRESS FOR WHICH THE RATES ARE BEING SPECIFIED, TYPICALLY BROADCAST OR A MULTICAST ADDRESS.
REFADDR2	6 OCTETS	OPTIONAL. PRESENT IF NUMADDR>=2. THE THIRD MAC ADDRESS FOR WHICH THE RATES ARE BEING SPECIFIED.
•••		[ADDITIONAL INSTANCES OF REFADDR, UNTIL THE NUMBER OF REFADDR FIELDS EQUALS NUMADDR]
NEXT ETHERTYPE	2 OCTETS	=0
PAD		TO REACH MINFRAMESIZE IF REQUIRED
FCS	4 OCTETS	FRAME CHECK SEQUENCE

FIG. 40

PE	DATA RATE	MEANING
0	N/A	MEANS THIS BAND IS NOT SUPPORTED
1	4 MBIT/S	2 MBAUD FDQAM, 2 BITS PER BAUD
2	6 MBIT/S	2 MBAUD FDQAM, 3 BITS PER BAUD
3	8 MBIT/S	2 MBAUD FDQAM, 4 BITS PER BAUD
4	10 MBIT/S	2 MBAUD FDQAM, 5 BITS PER BAUD
5	12 MBIT/S	2 MBAUD FDQAM, 6 BITS PER BAUD
6	14 MBIT/S	2 MBAUD FDQAM, 7 BITS PER BAUD
7	16 MBIT/S	2 MBAUD FDQAM, 8 BITS PER BAUD
8	1 MBIT/S	HPNA 1.0
9	8 MBIT/S	4 MBAUD QAM, 2 BITS PER BAUD
10	12 MBIT/S	4 MBAUD QAM, 3 BITS PER BAUD
11	16 MBIT/S	4 MBAUD QAM, 4 BITS PER BAUD
12	20 MBIT/S	4 MBAUD QAM, 5 BITS PER BAUD
13	24 MBIT/S	4 MBAUD QAM, 6 BITS PER BAUD
14	28 MBIT/S	4 MBAUD QAM, 7 BITS PER BAUD
15	32 MBIT/S	4 MBAUD QAM, 8 BITS PER BAUD

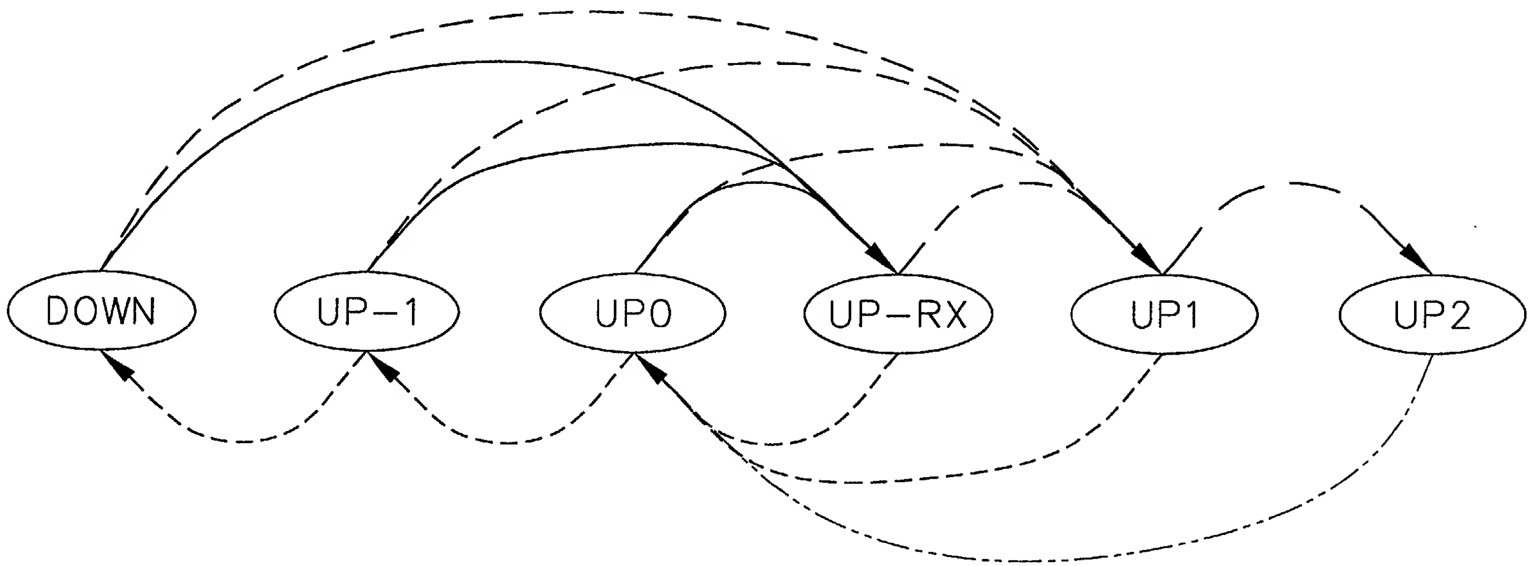
FIG. 41

OPCODE	MEANING
0	RATE CHANGE REQUEST
1	RATE TEST REQUEST
2	RATE TEST REPLY
3–255	RESERVED

FIG.42

BAND SPECIFICATION	A PAYLOAD ENCODING (PE) AND RANK ASSOCIATED WITH A GIVEN BAND. A BAND IS A SINGLE COMBINATION OF BAUD RATE, MODULATION TYPE (E.G. QAM OR FDQAM) AND CARRIER FREQUENCY. TWO BANDS ARE DEFINED IN HPNAVZ
LOGICAL CHANNEL, CHANNEL	A FLOW OF FRAMES FROM A SENDER TO ONE OR MORE RECEIVERS ON A SINGLE NETWORK SEGMENT, CONSISTING OF ALL THE FRAMES WITH A SINGLE COMBINATION OF DA AND SA.
RECEIVER	A STATION THAT RECEIVES FRAMES SENT ON A PARTICULAR CHANNEL. IF THE DESTINATION IS A UNICAST ADDRESS THERE IS AT MOST ONE RECEIVER. IF THE DESTINATION IS A GROUP ADDRESS (INCLUDING BROADCAST), THERE MAY BE MANY RECEIVERS.
RECEIVER PE	THE PREFERRED PE TO BE USED ON THIS CHANNEL, AS DETERMINED BY THE RECEIVER.
RRCF	RATE REQUEST CONTROL FRAME. SENT FROM THE RECEIVER TO THE SENDER TO EFFECT A CHANGE IN PE.
REFADDR0	THE SA IN THE ETHERNET HEADER OF THE RRCF FRAME. THIS IS THE DA OF THE RECEIVER (FOR THE CHANNEL), AND IS ALWAYS USED BY THE CHANNEL SENDER AS THE FIRST REFADDR PROCESSED.
REFADDR1.. REFADDR<n>	OTHER ADDRESSES INCLUDING BROADCAST AND MULTICAST ADDRESSES FOR WHICH THE RECEIVER IS INDICATING RATE INFORMATION TO THE SENDER. THE CHANNEL RECEIVER'S STATION ADDRESS (REFADDR0) SHOULD NOT BE PUT IN THE LIST OF ADDITIONAL REFADDR'S. NOTE 1: AT LEAST ONE REFADDR FIELD IS NECESSARY TO SUPPORT RATE NEGOTIATION FOR BROADCAST AND MULTICAST ADDRESSES SINCE THESE CANNOT BE USED AS THE SOURCE ADDRESS IN THE ETHERNET HEADER.
SENDER	THE SENDING STATION FOR A CHANNEL, USUALLY THE STATION OWNING THE SOURCE MAC ADDRESS.
SENDER PE	THE PREFERRED PE ASSOCIATED WITH A CHANNEL, AS NOTED BY THE SENDER.

FIG. 43a



→ RECEIVE ANY NON-BROADCAST FRAME OR LINK INDICATION

→ RECEIVE A FRAME WITH DA==BROADCAST (0xFFFFFFFFFFFF)-SET SA1=SA

→ RECEIVE A FRAME WITH DA==BROADCAST (0xFFFFFFFFFFFF) AND SA !=SA1

→ TIMEOUT OF 1 SECOND FREE-RUNNING TIMER-SEND LICF, REINITIALIZE FORCE_SEND

→ TIMEOUT-IF FORCE_SEND==0 THEN SEND LICF, REINIT FORCE_SEND ELSE DECREMENT FORCE_SEND

FIG. 43b

	DOWN	UP-1	UP0	UP-RX	UP1	UP2
RECEIVE 1.0 LINK INDICATION OR ANY NON-BROADCAST FRAME	UP-RX (NONE)	UP-RX (NONE)	UP-RX (NONE)	UP-RX (NONE)	UP1 (NONE)	UP2 (NONE)
RECEIVE BROADCAST FRAME WITH SA=SA1	UP1 SET SA1<-SA	UP1 SET SA1<-SA	UP1 SET SA1<-SA	UP1 SET SA1<-SA	UP1 (NONE)	UP2 (NONE)
RECEIVE BROADCAST FRAME WITH SA !=SA1	UP1 SET SA1<-SA	UP1 SET SA1<-SA	UP1 SET SA1<-SA	UP1 SET SA1<-SA	NATIVE: UP2 COMPAT: UP1 (NONE)	UP2 (NONE)
TIMEOUT AND FORCE_SEND=0	DOWN SEND LICF,REINIT FORCE_SEND	DOWN SEND LICF,REINIT FORCE_SEND	UP-1 SEND LICF,REINIT FORCE_SEND	UP0 SEND LICF,REINIT FORCE_SEND	UP0 SEND LICF,REINIT FORCE_SEND	UP0 SEND LICF,REINIT FORCE_SEND
TIMEOUT AND FORCE_SEND>0	DOWN SEND LICF,REINIT FORCE_SEND	DOWN SEND LICF,REINIT FORCE_SEND	UP-1 SEND LICF,REINIT FORCE_SEND	UP0 SEND LICF,REINIT FORCE_SEND	UP0 SEND LICF,REINIT FORCE_SEND	UP0 DECREMENT FORCE_SEND

FIG.44

FIELD	LENGTH	MEANING
DA	6 OCTETS	DESTINATION ADDRESS (FF.FF.FF.FF.FF.FF)
SA	6 OCTETS	SOURCE ADDRESS
ETHERTYPE	2 OCTETS	0x886c (LINK CONTROL FRAME)
SSTYPE	1 OCTET	=2
SSLENGTH	1 OCTET	NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD AND ENDING WITH THE SECOND(LAST) OCTET OF THE NEXT ETHERYPE FIELD. MINIMUM IS 4 FOR SSVERSION 0.
SSVERSION	1 OCTET	=0
LI_PAD	1 OCTET	IGNORED ON RECEPTION.
NEXT ETHERTYPE	2 OCTETS	=0
PAD	41 OCTETS	ANY VALUE OCTET
FCS	4 OCTETS	

FIG.45

FIELD	LENGTH	MEANING
DA	6 OCTETS	DESTINATION ADDRESS(FF.FF.FF.FF.FF.FF)
SA	6 OCTETS	SOURCE ADDRESS OF THE STATION THAT TRANSMITTED THIS FRAME
ETHERTYPE	2 OCTETS	0x886c (LINK CONTROL FRAME)
SSTYPE	1 OCTET	=3
SSLENGTH	1 OCTET	NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD AND ENDING WITH THE SECOND(LAST) OCTET OF THE NEXT ETHERYPE FIELD. MINIMUM IS 32 FOR SSVERSION 0.
SSVERSION	1 OCTET	=0
CSA_ID_SPACE	1 OCTET	IDENTIFIES THE REGISTRATION SPACE OF CSA_MFR_ID 0-UNSPECIFIED 1-JEDEC 2-PCI
CSA_MFR_ID	2 OCTETS	HW MANUFACTURER ID-IDENTIFIES THE MANUFACTURER OF THE PHY CONTROLLER CHIP. THE PURPOSE OF THIS FIELD PLUS THE PART NUMBER AND REVISION IS TO IDENTIFY SPECIFIC IMPLEMENTATIONS OF THE PHY SPECIFICATION. THIS IS NOT A BOARD OR ASSEMBLY-LEVEL IDENTIFIER.
CSA_PART_NO	2 OCTETS	HW MANUFACTURER PART NUMBER-THE PART NUMBER OF THE PHY CONTROLLER CHIP.
CSA_REV	1 OCTET	HW REVISION
CSA_OPCODE	1 OCTET	0-ANNOUNCE 1-REQUEST
CSA_MTU	2 OCTETS	MAXIMUM SIZE LINK-LEVEL PDU THIS RECEIVER ACCEPTS IN OCTETS, THE DEFAULT VALUE IS 1526 OCTETS. THIS IS ALSO THE MINIMUM VALUE THAT SHALL BE ACCEPTED BY ALL ILINE10 STATIONS.
CSA_SA	6 OCTETS	SOURCE ADDRESS OF THE STATION THAT GENERATED THIS CSA FRAME
CSA_PAD	2 OCTETS	RESERVED FOR VERSION 0. SHALL BE SENT AS 0, IGNORED ON RECEPTION.
CSA_ CURRENTTXSET	4 OCTETS	CONFIGURATION FLAGS, PLUS ALL CURRENT IN-USE STATUS FOR THIS STATION.
CSA_ OLDESTTXSET	4 OCTETS	A COPY OF THE "OLDEST" TX FLAGS FOR THIS STATIONS, FROM THE PERIOD ENDING AT LEAST ONE PERIOD (MINUTE) EARLIER.
CSA_ CURRENTRXSET	4 OCTETS	THE UNION OF RECENT FLAGS RECEIVED FROM OTHER STATIONS.
NEXT ETHERTYPE	2 OCTETS	=0
PAD		PAD TO REACH MINFRAMESIZE IF NECESSARY
FCS	4 OCTETS	

Octet	Field	Length	Description
Flags0	TxPriority7	1	Station is(was) transmitting frames with LL priority 7. (always set)
	TxPriority6	1	Station is(was) transmitting frames with LL priority 6.
	TxPriority5	1	Station is(was) transmitting frames with LL priority 5.
	TxPriority4	1	Station is(was) transmitting frames with LL priority 4.
	TxPriority3	1	Station is(was) transmitting frames with LL priority 3.
	TxPriority2	1	Station is(was) transmitting frames with LL priority 2.
	TxPriority1	1	Station is(was) transmitting frames with LL priority 1.
	TxPriority0	1	Station is(was) transmitting frames with LL priority 0. (always set)
Flags1	Reserved	6	Shall be sent as 0 and ignored by 2.0 stations when received.
	No_V1M2_Frames	1	This station does not support the reception or transmission of compatibility frames (V1M2 frames).
	Supports 4Mbaud	1	This station supports 4 megabaud payload encodings.
Flags2	Reserved	8	Shall be sent as 0 and ignored by 2.0 stations when received.
Flags3	ConfigV2	1	Force use of 10M8 mode, defers to Config1 and ConfigV1M2.
	ConfigV1M2	1	Force use of V1M2 mixed mode, defers to ConfigV1.
	ConfigV1	1	Force use of HPNA 1.x mode, highest precedence of config flags.
	Reserved	2	Shall be sent as 0 and ignored by 2.0 stations when received.
	Highest Version	3	This station's highest supported HPNA version: 0x000 – Reserved 0x001 – HPNA1.0 0x010 – iLine10 0x011-0x111 Reserved

Fig. 46

DeleteSet	A computed value used to detect newly removed status information.
NewRxFlags, ReallyNewRxFlags	Computed values used to detect new status flags.

Fig. 47

CSP_Timer	A free-running timer with a period of 60 seconds.
RetransmitTimer	A one-shot timer, set to a random interval in the range 1 ms to 1000 ms, inclusive, after sending a CSA in which CSA_CurrentTxSet and CSA_OldestTxSet are different, or when a CSA is received with the CSA_Opcode set to 1 (Request). This timer is cancelled if a second CSA is sent as a result of the CSP_Timer expiring.

Fig. 48

NewTxSet	The set of flags announced during the current CS period, updated immediately when a new link layer priority is used or new volatile status is set. When the CSP_Timer expires, CurrentTxSet is given the value of NewTxSet, and NewTxSet is reset to the **default** set.
PreviousTxSet	The set of flags that were announced during the previous CS period (the ending value of NewTxSet from the previous CS period).
OldestTxSet	The set of flags rolled over from PreviousTxSet at the end of the previous CS period (the value of PreviousTxSet from the previous CS period). Flags that are present in OldestTxSet and missing from PreviousTxSet were not actively used or detected (by the sender) for an entire CS period, and will be deleted. This set is sent in CSA frames as CSA_OldestTxSet.
NewRxSet	The union of all CSA_CurrentTxSet flags received in CSAs from other stations during the current CS period. This is rolled over into PreviousRxSet at the expiration of the CSP_Timer, then reset to the empty set (0). A volatile status flag (one of the priority flags) in this set may subsequently be deleted if the only station previously announcing that flag stops using it. The deletion from that station's CurrentTxSet is noted by the difference from its OldestTxSet. The fact that it was the only sender is noted by the absence of the flag in that station's CurrentRxSet, indicating that it has received the flag from no other stations. If deleted from NewRxSet, a flag shall also be deleted from PreviousRxSet.
PreviousRxSet	The set of announced flags received during the previous CS period (the ending value of NewRxSet from the previous CS period). A flag may be deleted from this set, as described under NewRxSet above.

Fig. 49

CurrentTxSet	The set of flags that were announced during the previous CS period plus any new status and priority flags (or changed configuration/options flags) used during the current CS period, i.e. the union of PreviousTxSet and NewTxSet. This set is sent in CSA frames as CSA_CurrentTxSet.
CurrentRxSet	The union of NewRxSet, PreviousRxSet. This set is sent in CSA frames as CSA_CurrentRxSet.
CurrentInUseSet	The union of CurrentTxSet and CurrentRxSet. This set is used to determine the operational mode of the station and to modify the mapping between the LL priority of the frame and the actual PHY priority usage.

Fig. 50

FIG. 51a

									TX LL PRIORITY							
									0	1	2	3	4	5	6	7
CURRENTINUSE PRIORITIES (ANY)									DEFAULT TX PHY PRIORITIES							
A	N	Y	T	X	S	E	T		2	0	1	3	4	5	7	6

FIG. 51b

									TX LL PRIORITY							
									0	1	2	3	4	5	6	7
CURRENTINUSE PRIORITIES (LL)									REMAPPED TX PHY PRIORITIES							
0							7		6	5	5	6	6	6	6	7
0						6	7		5	4	4	5	5	5	7	6
0	1			4			7		5	4	4	5	6	6	7	7
0			3		5	6	7		3	2	2	4	4	5	7	6

FIG.52a

FIELD	LENGTH	MEANING
DA	6 OCTETS	DESTINATION ADDRESS
SA	6 OCTETS	SOURCE ADDRESS
ETHERTYPE	2 OCTETS	0x886c (LINK CONTROL FRAME)
SSTYPE	1 OCTET	=4
SSLENGTH	1 OCTET	NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD AND ENDING WITH THE SECOND(LAST) OCTET OF THE NEXT ETHERYPE FIELD. SSLENGTH IS 6 FOR SSVERSION 0.
SSVERSION	1 OCTET	=0
LARQ_HDR DATA	3 OCTETS	LARQ CONTROL HEADER DATA WITH LARQ_CTL BIT=1,LARQ_NACK=0.
NEXT ETHERTYPE	2 OCTETS	=0
PAD	38 OCTETS	
FCS	4 OCTETS	FRAME CHECK SEQUENCE

FIG.52b

FIELD	LENGTH	MEANING
DA	6 OCTETS	DESTINATION ADDRESS
SA	6 OCTETS	SOURCE ADDRESS
ETHERTYPE	2 OCTETS	0x886c (LINK CONTROL FRAME)
SSTYPE	1 OCTET	=4
SSLENGTH	1 OCTET	NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD AND ENDING WITH THE SECOND(LAST) OCTET OF THE NEXT ETHERYPE FIELD. SSLENGTH IS 12 FOR NACK FRAMES WITH SSVERSION 0.
SSVERSION	1 OCTET	=0
LARQ_HDR DATE	3 OCTETS	LARQ CONTROL HEADER DATA WITH LARQ_CTL BIT=1,LARQ_NACK=1..7.
NACK_DA	6 OCTETS	ORIGINAL DESTINATION ADDRESS
NEXT ETHERTYPE	2 OCTETS	=0
PAD	32 OCTETS	
FCS	4 OCTETS	FRAME CHECK SEQUENCE

FIG.52c

FIELD	LENGTH	MEANING
DA	6 OCTETS	DESTINATION ADDRESS (FROM ORIGINAL ETHERNET PDU)
SA	6 OCTETS	SOURCE ADDRESS (FROM ORIGINAL ETHERNET PDU)
ETHERTYPE	2 OCTETS	0x886c (LINK CONTROL FRAME)
SSTYPE	1 OCTET	=4
SSLENGTH	1 OCTET	NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD AND ENDING WITH THE SECOND(LAST) OCTET OF THE NEXT ETHERYPE FIELD. SSLENGTH IS 6 FOR SSVERSION 0.=6
SSVERSION	1 OCTET	=0
LARQ_HDR DATA	3 OCTETS	LARQ ENCAPSULATION HEADER DATA (WITH LARQ_CTL BIT=0)
NEXT ETHERTYPE	2 OCTETS	FROM ORIGINAL ETHERNET PDU
PAYLOAD	MIN 46 OCTETS	FROM ORIGINAL ETHERNET PDU PAYLOAD
FCS	4 OCTETS	FRAME CHECK SEQUENCE

FIG.52d

OCTET	FIELD	LENGTH	MEANING
FLAGS0	LARQ_MULT	1 BIT	MULTIPLE RETRANSMISSION FLAG. 0 IN THE ORIGINAL TRANSMISSION OF A DATA FRAME. FOR RETRANSMITTED FRAMES (LARQ_RTX=1), SET TO THE VALUE OF LARQ_MULT IN THE NACK FRAME THAT CAUSED THE RETRANSMISSION. THIS CAN BE USED BY RECEIVERS TO MEASURE THE ROUND-TRIP TIMES ASSOCIATED WITH THE MISS/NACK/RECEIVE-RTX PROCESS.
	LARQ_RTX	1 BIT	0 FOR FIRST TRANSMISSION OF A FRAME, 1 IF FRAME IS RETRANSMITTED. STATIONS NOT IMPLEMENTING LARQ SHALL DROP ANY DATA FRAME IF THIS BIT IS 1.
	LARQ_NORTX	1 BIT	0 IF IMPLEMENTATION SUPPORTS RETRANSMISSION, 1 IF ONLY PRIORITY IS MEANINGFUL. MAY BE USED ON A PERCHANNEL BASIS.
	LARQ_NEWSEQ	1 BIT	1 IF THE SEQUENCE NUMBER SPACE FOR THE CHANNEL HAS BEEN RESET, AND OLDER SEQUENCE NUMBERS SHOULD NOT BE NACKED, 0 OTHERWISE.
	LARQ_CTL	1 BIT	"0" WHEN IN ENCAPSULATION FORMAT
	PRIORITY	3 BITS	LINK LAYER PRIORITY OF THIS FRAME
FLAGS1_SEQ0	RESERVED	4 BITS	RESERVED, SHALL BE 0
	LARQ_SEQ_HIGH	4 BITS	HIGH 4 BITS OF SEQUENCE NUMBER
SEQ1	LARQ_SEQ_LOW	8 BITS	LOW 8 BITS OF SEQUENCE NUMBER

FIG.52e

OCTET	FIELD	LENGTH	MEANING
FLAGS0	LARQ_MULT	1 BIT	MULTIPLE RETRANSMISSION FLAG. 0 IN THE FIRST NACK SENT FOR A GIVEN SEQUENCE NUMBER, 1 IN ALL RETRANSMITTED NACKS.
	LARQ_NACK	3 BITS	NACK COUNT IF 0 IN A LARQ CONTROL FRAME, THEN THIS IS A REMINDER.
	LARQ_CTL	1 BIT	SET TO 1 FOR LARQ CONTROL HEADER DATA FORMAT
	PRIORITY	3 BITS	LINK LAYER PRIORITY OF THIS FRAME
FLAGS1_SEQ0	RESERVED	4 BITS	RESERVED, SHALL BE 0
	LARQ_SEQ_HIGH	4 BITS	HIGH 4 BITS OF SEQUENCE NUMBER
SEQ1	LARQ_SEQ_LOW	8 BITS	LOW 8 BITS OF SEQUENCE NUMBER

FIG.52f.1

CONTROL FRAME	A FRAME GENERATED BY A LARQ PROTOCOL MODULE THAT CONTAINS ONLY A LARQ PROTOCOL HEADER AS ITS PAYLOAD.
CURRENT SEQUENCE NUMBER	THE MOST RECENTLY RECEIVED NEW SEQUENCE NUMBER FOR A CHANNEL.
DATA FRAME	ANY STANDARD ETHERNET FRAME FROM HIGHER (THAN LARQ) PROTOCOL LAYERS. A LARQ-ENABLED STATION ENCAPSULATES THE ORIGINAL PAYLOAD OF AN ETHERNET FRAME BY INSERTING A LARQ HEADER (SHORTER FORM CONTROL HEADER WITH LARQ_HDR DATA) BETWEEN THE SOURCE ADDRESS AND THE REMAINDER OF THE FRAME BEFORE THE FRAME IS PASSED DOWN TO THE DRIVER FOR TRANSMISSION ON THE NETWORK.
FORGET TIMER	AN IMPLEMENTATION DEPENDENT MECHANISM TO ALLOW A RECEIVER TO RESET THE SEQUENCE NUMBER SPACE OF A CHANNEL WHEN A RECEIVED SEQUENCE NUMBER IS NOT THE NEXT EXPECTED (CURRENT SEQUENCE NUMBER+1). ONE SECOND IS A SUGGESTED DEFAULT VALUE.
HOLD TIMER, LOST TIMER	AN IMPLEMENTATION DEPENDENT TIMING MECHANISM THAT LIMITS THE TIME A RECEIVER WILL HOLD ONTO A RECEIVED FRAME WHILE WAITING FOR A MISSING FRAME TO BE RETRANSMITTED. CONCEPTUALLY, THERE IS ONE SUCH TIMER PER MISSING SEQUENCE NUMBER. THE TIMER INTERVAL IS MAXIMUM HOLD INTERVAL.
LOGICAL CHANNEL, CHANNEL	A FLOW OF FRAMES FROM A SENDER TO ONE OR MORE RECEIVERS ON A SINGLE NETWORK SEGMENT CONSISTING OF ALL THE FRAMES WITH A SINGLE COMBINATION OF DESTINATION ADDRESS, SOURCE ADDRESS, AND LINK LAYER PRIORITY.
NACK, NACK, NACK	AN INDICATION FROM A RECEIVER TO A SENDER REQUESTING RETRANSMISSION OF ONE OR MORE FRAMES. ALSO, THE ACTION OF PROVIDING SUCH AN INDICATION. E.G. "TO NACK A SEQUENCE NUMBER" MEANING TO SEND A NACK INDICATION.
NACK TIMER	AN IMPLEMENTATION DEPENDENT TIMING MECHANISM USED BY A RECEIVER TO RETRANSMIT NACKS FOR MISSING SEQUENCE NUMBERS. CONCEPTUALLY, THERE IS ONE SUCH TIMER PER MISSING SEQUENCE NUMBER PER LOGICAL CHANNEL. THE TIMER IS RESET EACH TIME A NACK IS SENT FOR A SEQUENCE NUMBER. THE TIMER INTERVAL IS NACK RETRANSMISSION INTERVAL.
NEW	A NEW SEQUENCE NUMBER IS ONE WHOSE DIFFERENCE FROM THE CURRENT SEQUENCE NUMBER FOR THE CHANNEL, MODULO THE SIZE OF THE SEQUENCE NUMBER SPACE AND CONSIDERED AS A SIGNED INTEGER, IS GREATER THAN 0. IN PARTICULAR, THE NUMBERS (CURRENT+1) THROUGH (CURRENT+2047).
OLD	AN OLD SEQUENCE NUMBER IS ONE WHOSE DIFFERENCE FROM THE CURRENT SEQUENCE NUMBER FOR THE CHANNEL, MODULO THE SIZE OF THE SEQUENCE NUMBER SPACE AND CONSIDERED AS A SIGNED INTEGER, IS LESS THAN OR EQUAL TO 0. IN PARTICULAR, THE NUMBERS (CURRENT-2048) THROUGH (CURRENT) ARE OLD. NOTE, HOWEVER, THAT MOST OF THE OLD SEQUENCE NUMBERS ARE ALSO OUT-OF-SEQUENCE.

FIG.52f.2

OUT OF SEQUENCE	ANY SEQUENCE NUMBER THAT FALLS OUTSIDE A REASONABLE RANGE, OLD OR NEW, OF THE CURRENT SEQUENCE NUMBER FOR A LOGICAL CHANNEL IS CONSIDERED OUT OF SEQUENCE. IT IS RECOMMENDED THAT PLUS OR MINUS TWICE THE VALUE OF MAXIMUMSAVELIMIT (DEFINED BELOW) BE USED AS THE "REASONABLE RANGE" WHEN CHECKING FOR OUT OF SEQUENCE.
RECEIVER	A STATION THAT RECEIVES FRAMES SENT ON A PARTICULAR CHANNEL. IF THE DESTINATION ADDRESS IS A UNICAST ADDRESS THERE IS AT MOST ONE RECEIVER. IF THE DESTINATION ADDRESS IS A GROUP ADDRESS (INCLUDING BROADCAST), THEN THERE MAY BE MANY RECEIVERS.
REMINDER	A CONTROL FRAME SENT BY THE CHANNEL SENDER WITH THE MOST RECENTLY USED SEQUENCE NUMBER FOR A CHANNEL WHICH HAS BEEN INACTIVE FOR REMINDER INTERVAL AFTER ITS MOST RECENT DATA FRAME.
REMINDER TIMER	AN IMPLEMENTATION DEPENDENT TIMING MECHANISM USED BY A SENDER TO GENERATE A REMINDER FRAME AFTER A PERIOD OF INACTIVITY FOR A CHANNEL. THE TIMER IS RESET EACH TIME A NEW DATA FRAME IS TRANSMITTED. CONCEPTUALLY, THERE IS ONE SUCH TIMER PER CHANNEL. THE TIMER INTERVAL IS REMINDER INTERVAL.
SAVE TIMER	AN IMPLEMENTATION DEPENDENT TIMING MECHANISM THAT LIMITS THE TIME A SENDER WILL SAVE A FRAME WAITING FOR RETRANSMISSION REQUESTS. THE TIMER INTERVAL IS MAXIMUM SAVE INTERVAL.
SENDER	THE SENDING STATION FOR A CHANNEL, USUALLY THE STATION OWNING THE SOURCE MAC ADDRESS.
SEQUENCE NUMBERS	SEQUENCE NUMBERS ARE MAINTAINED SEPARATELY FOR EACH LOGICAL CHANNEL BY THE SENDER.

FIG.53

SEND SEQUENCE NUMBER	THE SEQUENCE NUMBER OF THE MOST RECENTLY TRANSMITTED DATA FRAME.
REMINDER TIMER INTERVAL	A FIXED INTERVAL. THE DEFAULT IS 50 MS. LOWER VALUES WILL INCREASE THE OVERHEAD OF REMINDERS ON NETWORK LOAD, WHILE HIGHER VALUES INCREASE THE LATENCY FOR END-OF-SEQUENCE FRAMES REQUIRING RETRANSMISSION. IMPLEMENTATIONS SHOULD NOT USE VALUES OUTSIDE OF THE RANGE 25-75 MS, BASED ON 150 MS MAXIMUM SAVE AND HOLD TIMES.
MINIMUM RETRANSMISSION INTERVAL	AN INTERVAL USED TO PREVENT TOO-FREQUENT RETRANSMISSIONS OF A SINGLE FRAME. MOST IMPORTANT FOR MULTICAST CHANNELS. THE DEFAULT IS 10 MS.
MAXIMUM SAVE LIMIT	THE MAXIMUM NUMBER OF FRAMES THAT WILL BE SAVED FOR A SINGLE LOGICAL CHANNEL. THIS IMPLEMENTATION DEPENDENT, AND VARIES WITH THE MAXIMUM FRAME RATE THE SENDER IS EXPECTED TO SUPPORT. VALUES OF 100 OR MORE CAN BE USEFUL FOR HIGH-SPEED APPLICATIONS SUCH AS VIDEO.
MAXIMUM SAVE INTERVAL	THE MAXIMUM TIME THAT THE SENDER WILL NORMALLY SAVE A FRAME FOR POSSIBLE RETRANSMISSION. THE DEFAULT IS 150 MS.

FIG.54

CURRENT SEQUENCE NUMBER	THE MOST RECENT SEQUENCE NUMBER RECEIVED IN A LARQ HEADER FOR THE CHANNEL, WHETHER IN A DATA FRAME OR A REMINDER CONTROL FRAME.
OLDEST MISSING SEQUENCE NUMBER	THE OLDEST SEQUENCE NUMBER FOR A FRAME NOT YET RECEIVED WHICH HAS NOT BEEN DECLARED LOST.
MAXIMUM HOLD INTERVAL	THE LONGEST INTERVAL THAT A FRAME WILL BE HELD AWAITING AN EARLIER MISSING FRAME. THE DEFAULT IS TO USE THE SAME VALUE AS MAXIMUM SAVE INTERVAL, WHICH HAS A DEFAULT OF 150 MS.
MAXIMUM RECEIVE LIMIT	THE MAXIMUM NUMBER OF FRAMES THAT A RECEIVER WILL BUFFER WHILE AWAITING AN EARLIER MISSING FRAME. THE DEFAULT SHOULD NORMALLY BE THE SAME AS THE MAXIMUM SAVE LIMIT.
NACK RETRANSMISSION INTERVAL	THE INTERVAL AFTER WHICH A RECEIVER WILL RETRANSMIT A NACK CONTROL FRAME FOR A MISSING SEQUENCE NUMBER, WITH THE EXPECTATION THAT EARLIER NACK CONTROL FRAMES OR DATA FRAME RETRANSMISSIONS WERE LOST. THE DEFAULT FOR FIXED IMPLEMENTATIONS IS 20 MS.

FIG.55a

FIELD	LENGTH	MEANING
DA	6 OCTETS	DESTINATION ADDRESS
SA	6 OCTETS	SOURCE ADDRESS
ETHERTYPE	2 OCTETS	0x886c (LINK CONTROL FRAME)
SSTYPE	1 OCTET	=5
SSLENGTH	1 OCTET	NUMBER OF ADDITIONAL OCTETS IN THE CONTROL HEADER, STARTING WITH THE SSVERSION FIELD AND ENDING WITH THE SECOND(LAST) OCTET OF THE NEXT ETHERYPE FIELD. SSLENGTH SHALL BE>= 6 FOR SSVERSION 0.
SSVERSION	1 OCTET	=0
VENDOR OUI	3 OCTETS	AN IEEE ASSIGNED ORGANIZATIONALLY UNIQUE IDENTIFIER
CONTROL DATA	0-249 OCTETS	VENDOR SPECIFIC CONTROL DATA
NEXT ETHERTYPE	2 OCTETS	= NEXT ETHERTYPE IF AN ENCAPSULATION FORMAT, OR 0 IF NO ENCAPSULATED FRAME
PAD	0-38 OCTETS	ANY VALUE OCTET
FCS	4 OCTETS	

FIG.55b

FIELD	LENGTH	MEANING
DA	6 OCTETS	DESTINATION ADDRESS
SA	6 OCTETS	SOURCE ADDRESS
ETHERTYPE	2 OCTETS	0x886c (LINK CONTROL FRAME)
LSTYPE	2 OCTETS	=32769
LSLENGTH	2 OCTETS	NUMBER OF ADDITIONAL OCTETS STARTING WITH THE LSVERSION FIELD AND ENDING WITH THE SECOND(LAST) OCTET OF THE NEXT ETHERYPE FIELD. LSLENGTH SHALL BE>6 FOR LSVERSION 0.
LSVERSION	1 OCTET	=0
VENDOR OUI	3 OCTETS	AN IEEE ASSIGNED ORGANIZATIONALLY UNIQUE IDENTIFIER
CONTROL DATA	1-65531 OCTETS	VENDOR SPECIFIC DATA
NEXT ETHERTYPE	2 OCTETS	= NEXT ETHERTYPE IF AN ENCAPSULATION FORMAT, OR 0 IF NO ENCAPSULATED FRAME
PAD	40-0 OCTETS	IF NEEDED TO MAKE MINIMUM SIZE FRAME. SHOULD BE ZERO.
FCS	4 OCTETS	

FIG.56

CARRIER SENSE STATE	OUTPUT EVENTS
INIT	ENERGY<=0. ONLY START-OF-PREAMBLE EVENTS CHECKED.
IDLE	ONLY START-OF-PREAMBLE EVENTS CHECKED.
BUSY	ONLY END-OF-PREAMBLE EVENTS CHECKED.
TRANSMIT	ONLY START-OF-PREAMBLE EVENTS CHECKED(COLLISION DETECTION)

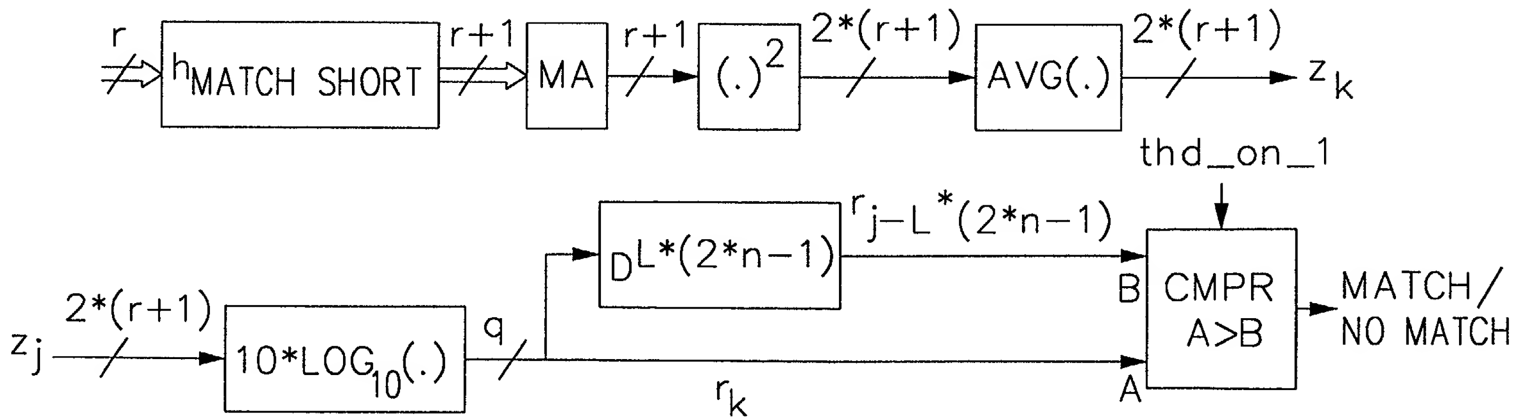
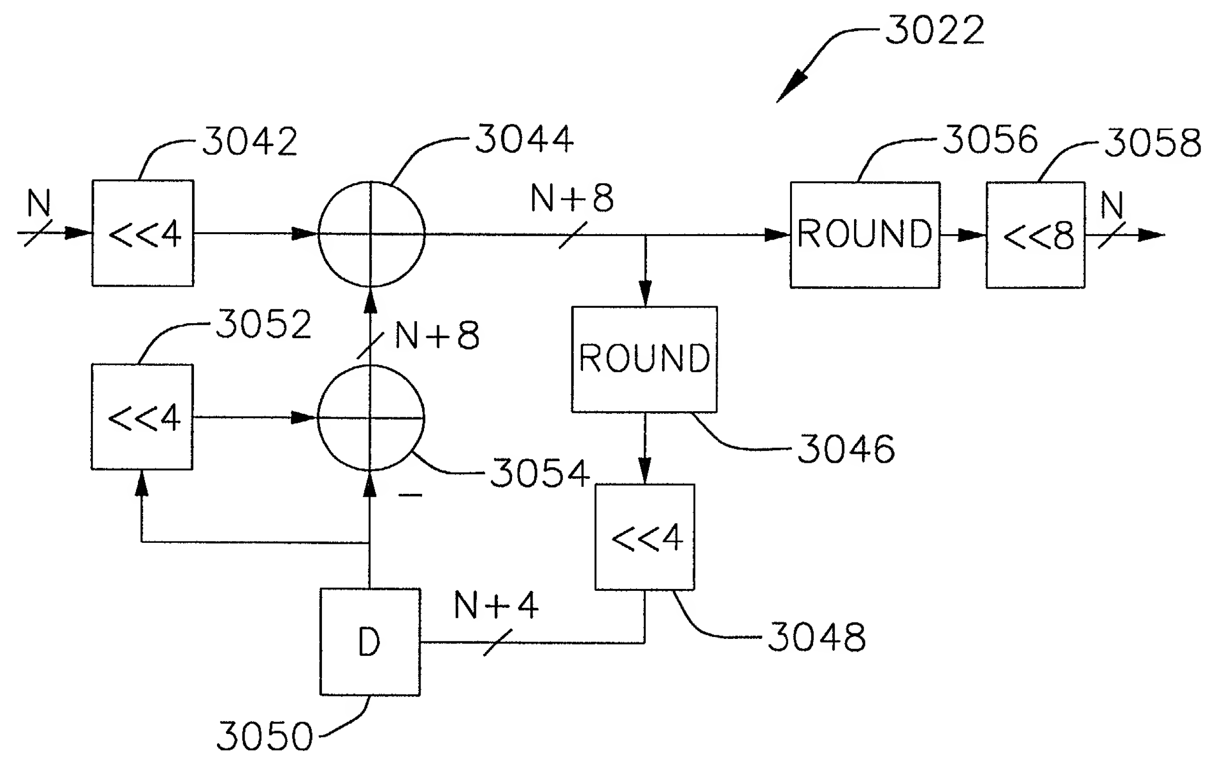


FIG.57

FIG.58



3022
3042
3044
3056
3058
N
<<4
N+8
ROUND
<<8
N
3052
N+8
ROUND
<<4
3054
3046
–
<<4
D
N+4
3048
3050

FIG. 59

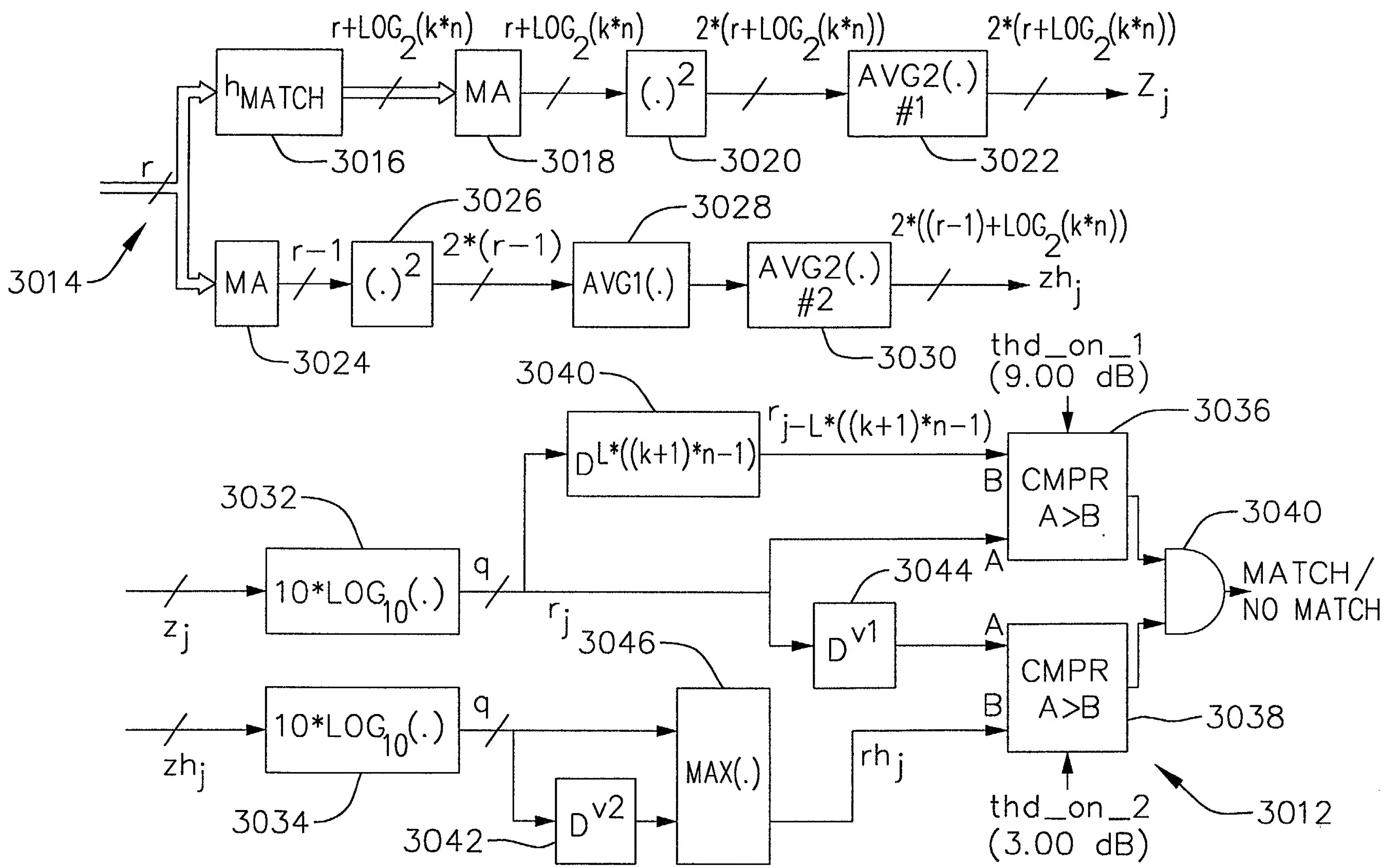
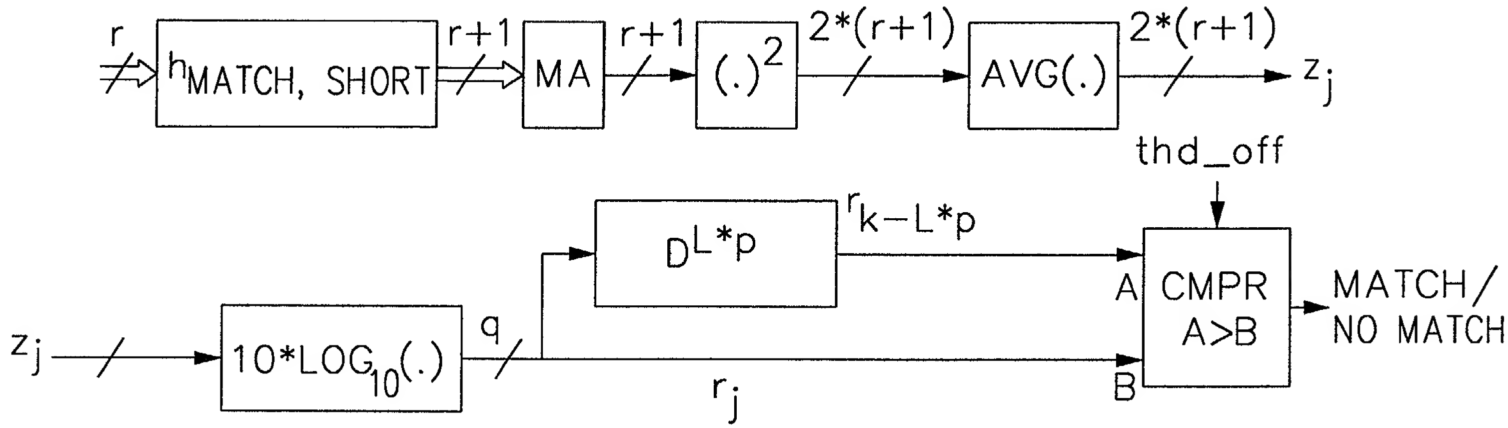
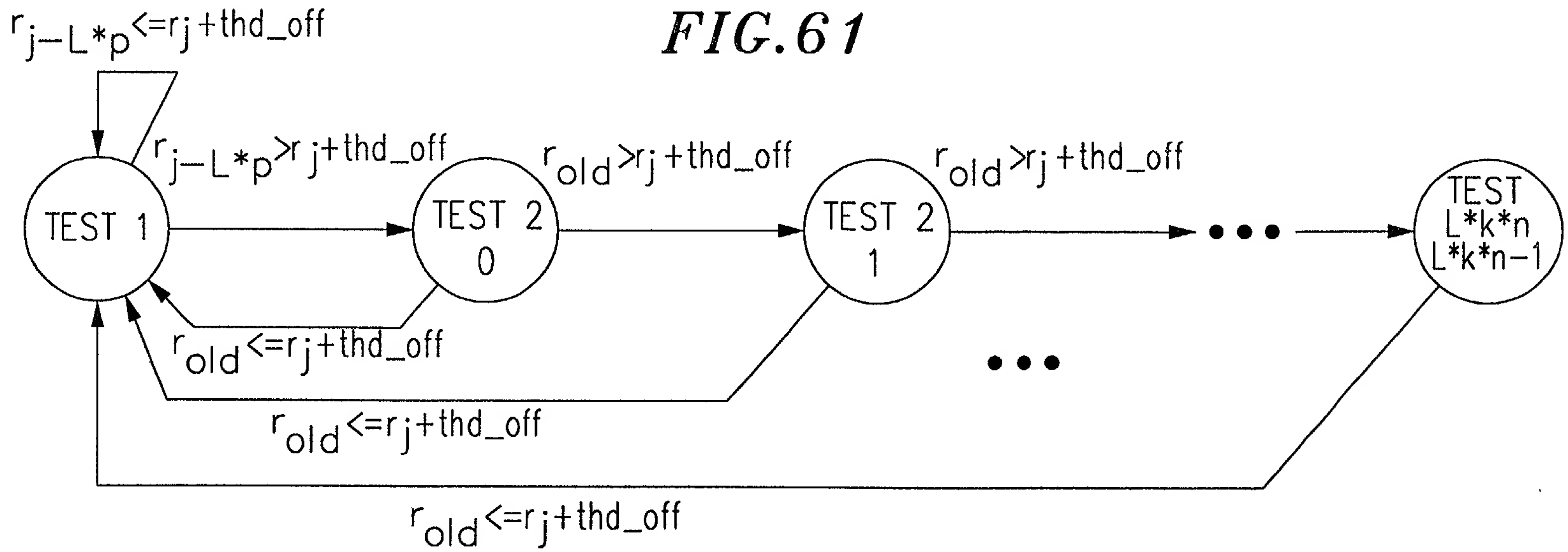

3010
r+LOG2(k*n)
r+LOG2(k*n)
2*(r+LOG2(k*n))
2*(r+LOG2(k*n))
hMATCH
MA
(.)2
AVG2(.) #1
Zj
3016
3018
3020
3022
r
3014
MA
r−1
(.)2
2*(r−1)
AVG1(.)
AVG2(.) #2
2*((r−1)+LOG2(k*n))
zhj
3024
3026
3028
3030
3040
DL*((k+1)*n−1)
rj−L*((k+1)*n−1)
thd_on_1
(9.00 dB)
3036
B
CMPR
A>B
A
3040
MATCH/
NO MATCH
3032
10*LOG10(.)
q
zj
rj
3044
Dv1
A
B
CMPR
A>B
3038
3046
MAX(.)
10*LOG10(.)
q
zhj
rhj
3034
3042
Dv2
thd_on_2
(3.00 dB)
3012

FIG.60



r
h MATCH, SHORT
r+1
MA
r+1
(.)2
2*(r+1)
AVG(.)
2*(r+1)
zj
thd_off
DL*p
rk−L*p
A
CMPR
A>B
MATCH/
NO MATCH
zj
10*LOG10(.)
q
rj
B

FIG.61



rj−L*p<=rj+thd_off
rj−L*p>rj+thd_off
rold>rj+thd_off
rold>rj+thd_off
TEST 1
TEST 2
0
TEST 2
1
TEST
L*k*n
L*k*n−1
rold<=rj+thd_off
rold<=rj+thd_off
rold<=rj+thd_off

FIG.62a

TABLE INDEX	TABLE VALUE (dB)
0	0.00
1	3.00
2	6.00
3	9.00
4	12.00
5	15.00
6	18.00
7	21.00
8	24.00
9	27.00
10	30.00
11	33.00
12	36.00
13	39.25
14	42.25
15	45.25
16	48.25
17	51.25
18	54.25
19	57.25
20	60.25
21	63.25
22	66.25
23	69.25
24	72.25
25	75.25
26	78.25
27	81.25
28	84.25
29	87.25
30	90.25
31	93.25

FIG.62b

TABLE INDEX	TABLE VALUE (dB)
0	0.00
1	0.25
2	0.25
3	0.50
4	0.50
5	0.75
6	0.75
7	0.75
8	1.00
9	1.00
10	1.25
11	1.25
12	1.50
13	1.50
14	1.50
15	1.75
16	1.75
17	1.75
18	2.00
19	2.00
20	2.00
21	2.25
22	2.25
23	2.25
24	2.50
25	2.50
26	2.50
27	2.75
28	2.75
29	2.75
30	2.75
31	3.00

FIG. 63a

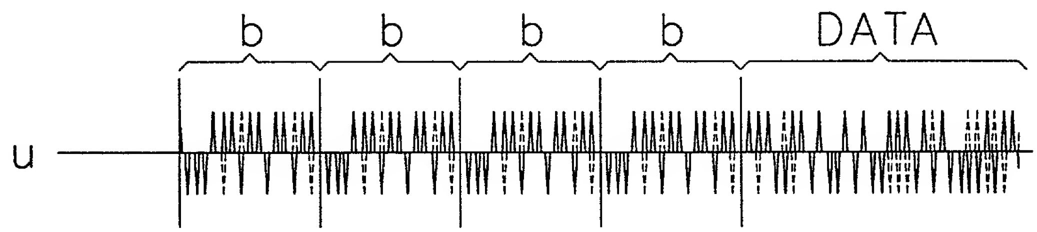


FIG. 63b

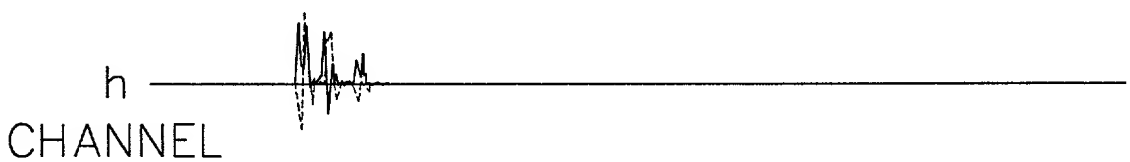


FIG. 63c

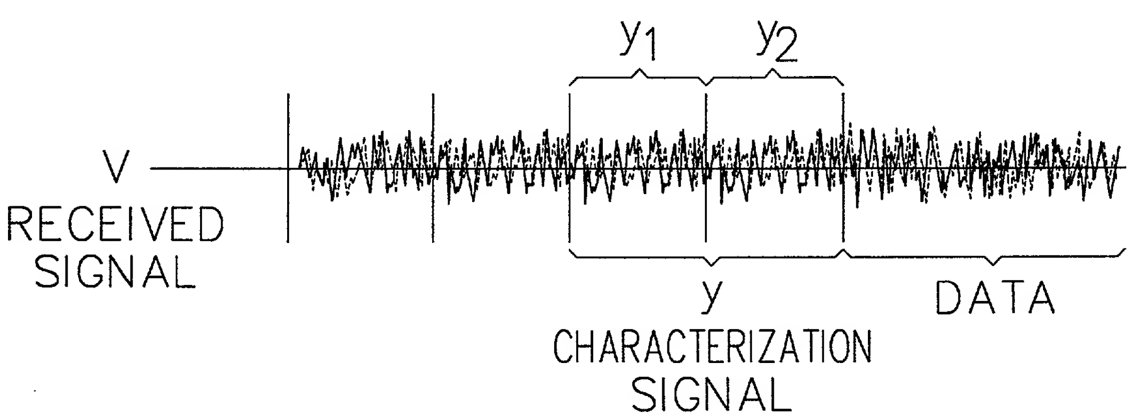
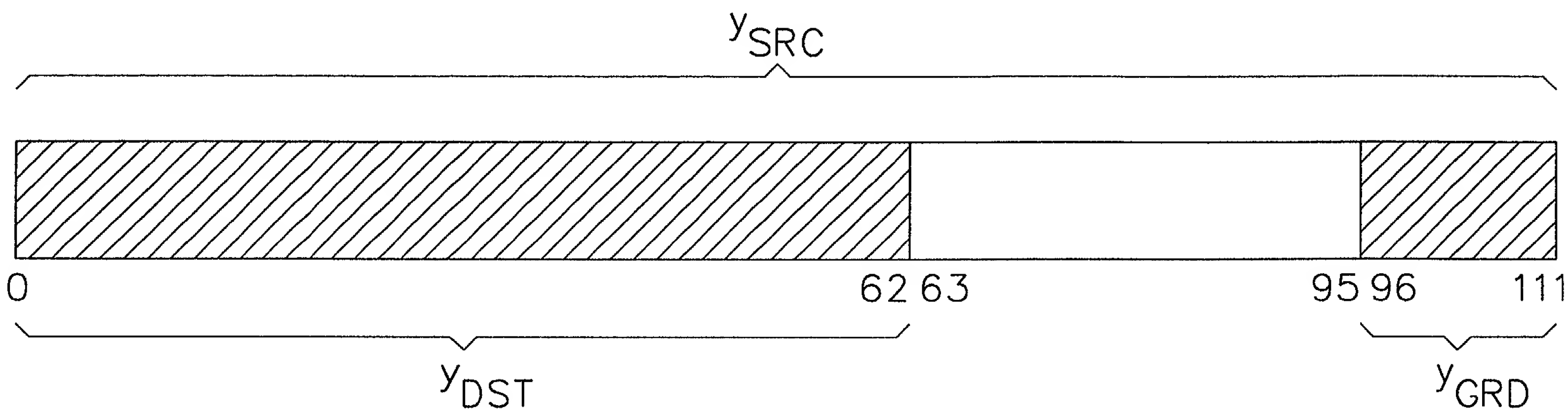
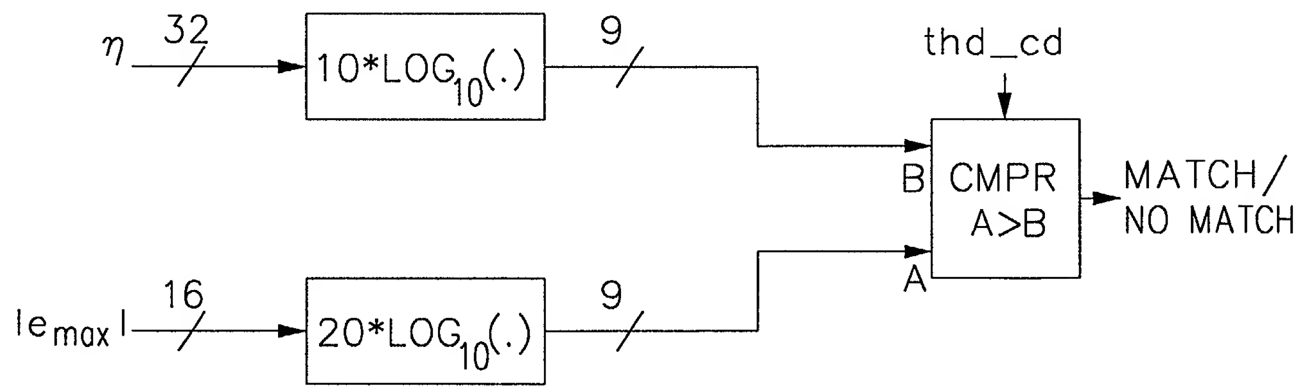


FIG.64



y_{SRC}
0
62 63
95 96
111
y_{DST}
y_{GRD}

FIG.65



η
32
$10*LOG_{10}(.)$
9
$|e_{max}|$
16
$20*LOG_{10}(.)$
9
thd_cd
B
A
CMPR
A>B
MATCH/
NO MATCH

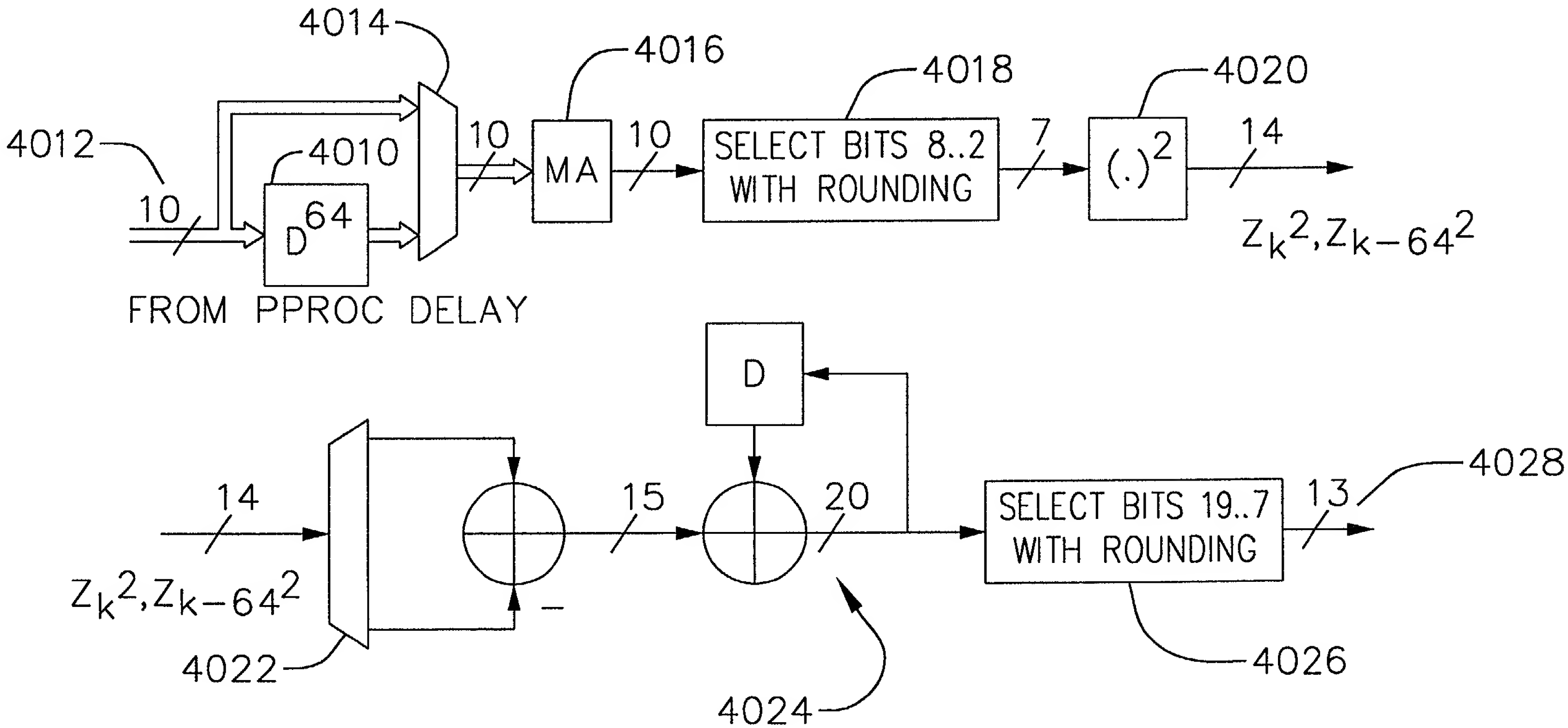
FIG.66a

TABLE INDEX	TABLE VALUE
0	0.00
1	6.00
2	12.00
3	18.00
4	24.00
5	30.00
6	36.00
7	42.25
8	48.25
9	54.25
10	60.25
11	66.25
12	72.25
13	78.25
14	84.25
15	90.25

FIG.66b

TABLE INDEX	TABLE VALUE
0	0.00
1	0.50
2	1.00
3	1.50
4	2.00
5	2.25
6	2.75
7	3.25
8	3.50
9	4.00
10	4.25
11	4.50
12	4.75
13	5.25
14	5.50
15	5.75

FIG. 67



4012
10
4010
D64
4014
FROM PPROC DELAY
10
4016
MA
10
4018
SELECT BITS 8..2
WITH ROUNDING
7
4020
(.)2
14
Zk2,Zk-642
14
Zk2,Zk-642
4022
15
D
20
4024
SELECT BITS 19..7
WITH ROUNDING
4026
13
4028

FIG.68

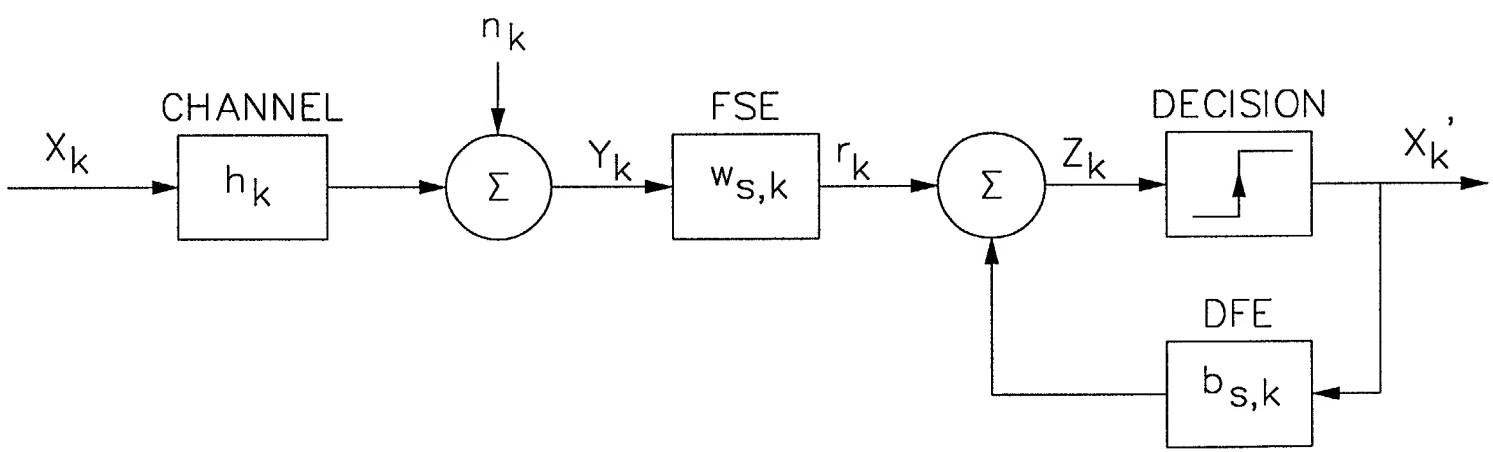
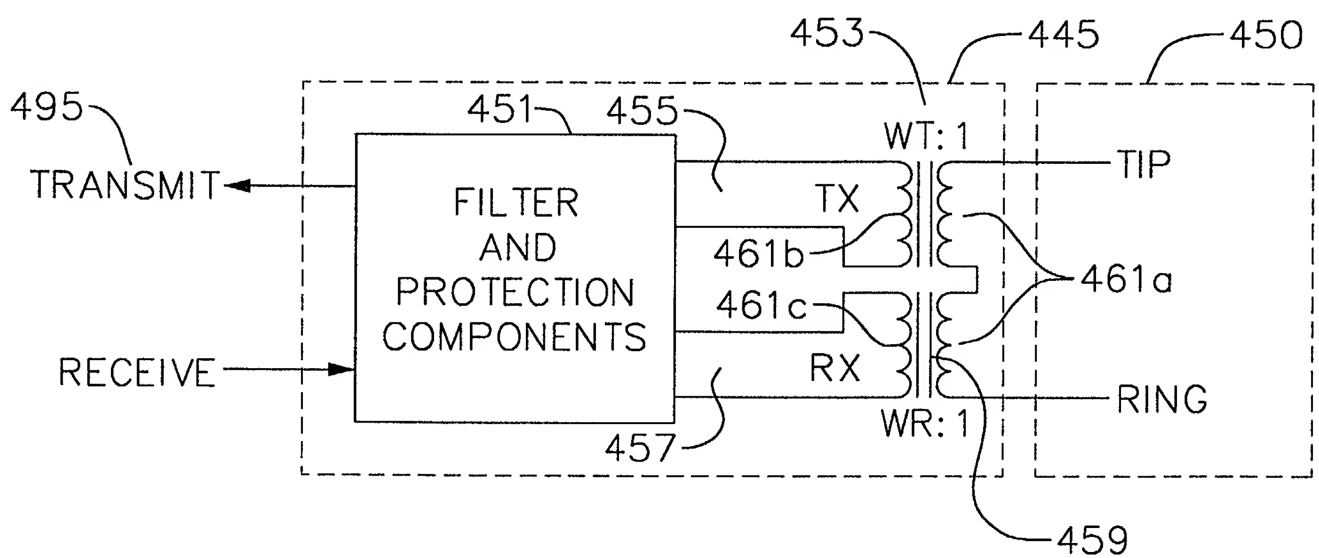


FIG. 69


495
TRANSMIT
RECEIVE
451
455
457
FILTER
AND
PROTECTION
COMPONENTS
453
445
450
WT: 1
TX
461b
461c
RX
WR: 1
461a
TIP
RING
459

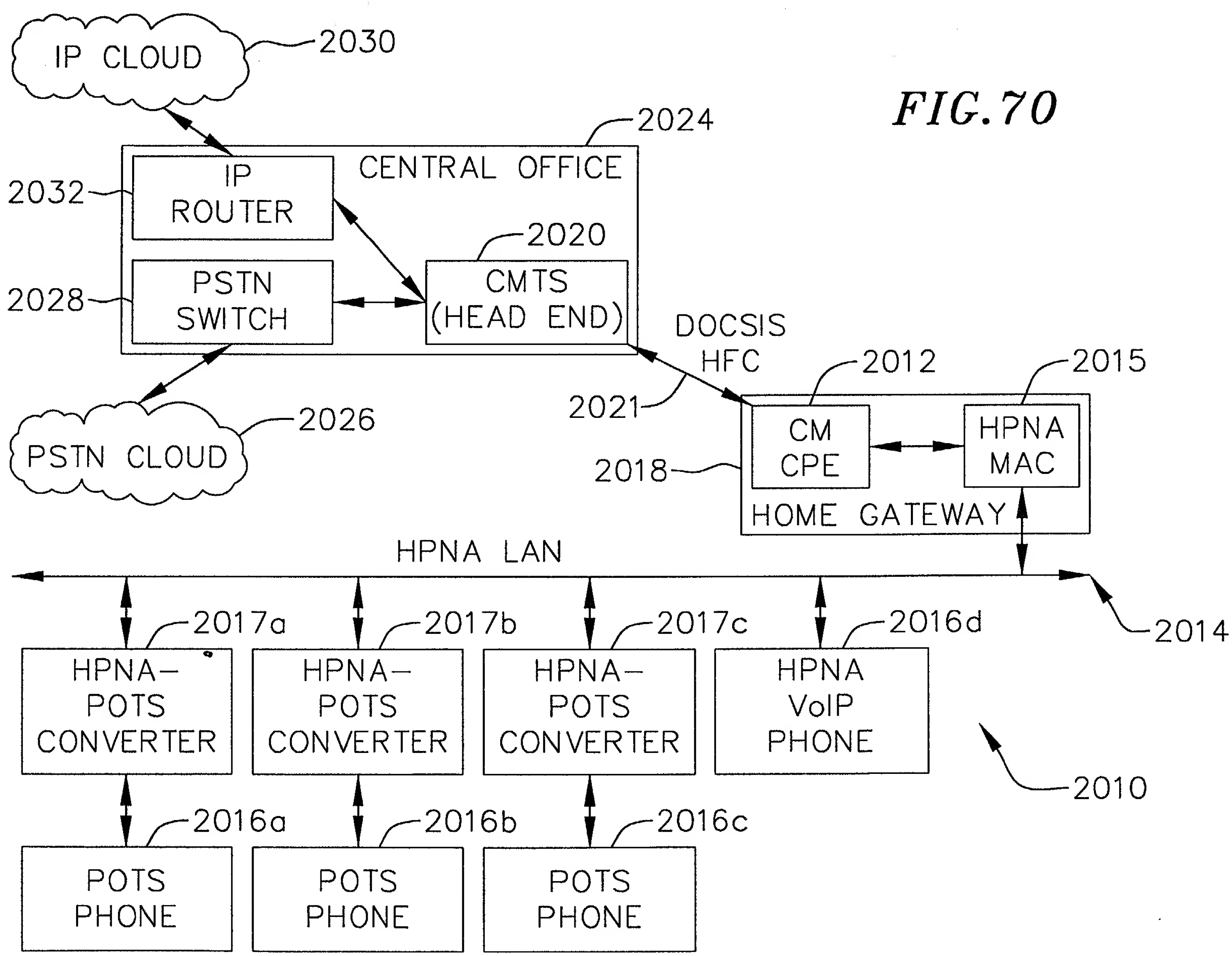

IP CLOUD
2030
2024
CENTRAL OFFICE
IP
ROUTER
2032
2020
PSTN
SWITCH
2028
CMTS
(HEAD END)
DOCSIS
HFC
2021
PSTN CLOUD
2026
2012
2015
CM
CPE
HPNA
MAC
2018
HOME GATEWAY
HPNA LAN
2014
2017a
2017b
2017c
2016d
HPNA-
POTS
CONVERTER
HPNA-
POTS
CONVERTER
HPNA-
POTS
CONVERTER
HPNA
VoIP
PHONE
2010
2016a
2016b
2016c
POTS
PHONE
POTS
PHONE
POTS
PHONE

FIG. 70

FIG.71

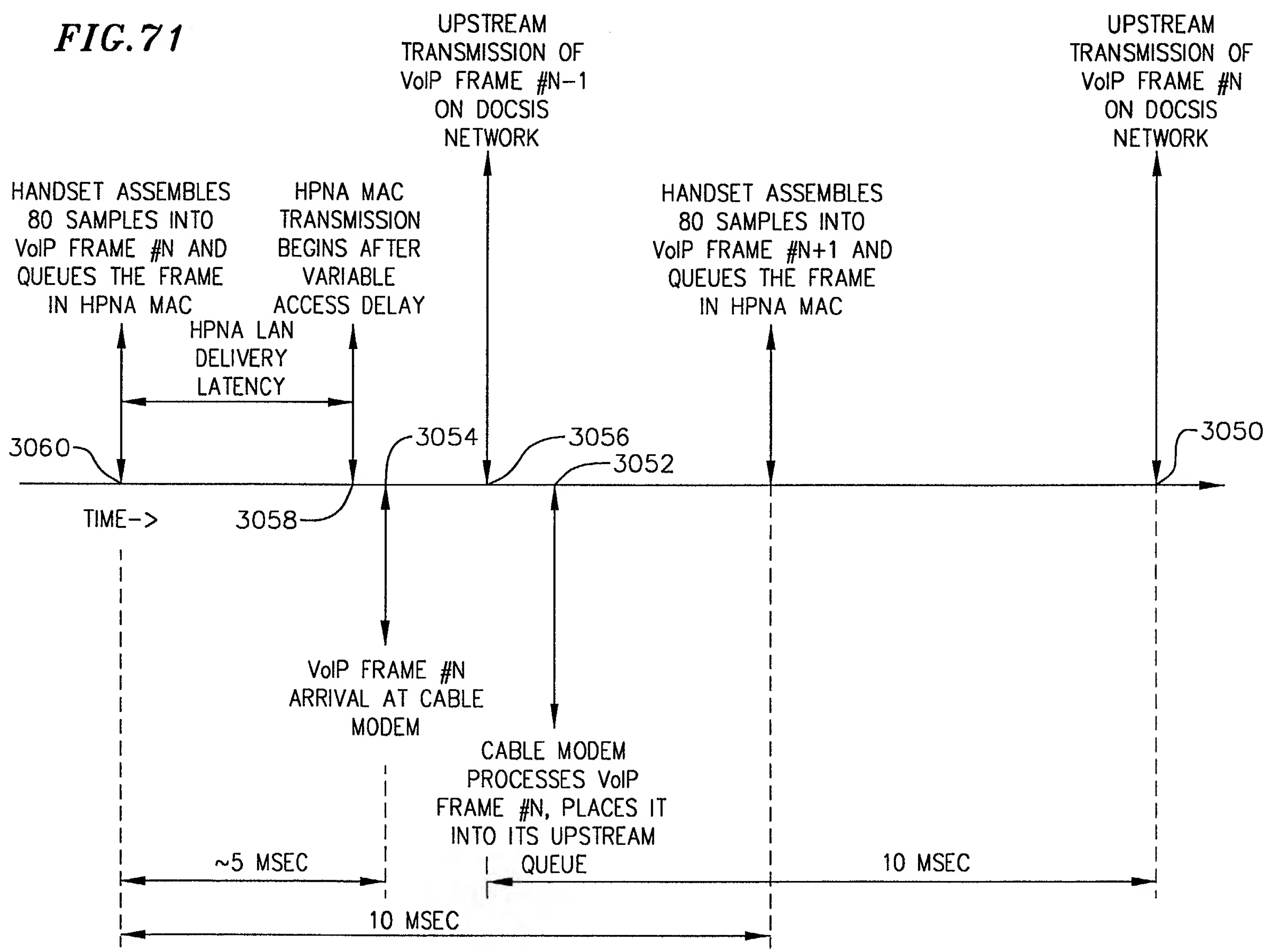

UPSTREAM TRANSMISSION OF VoIP FRAME #N-1 ON DOCSIS NETWORK
UPSTREAM TRANSMISSION OF VoIP FRAME #N ON DOCSIS NETWORK
HANDSET ASSEMBLES 80 SAMPLES INTO VoIP FRAME #N AND QUEUES THE FRAME IN HPNA MAC
HPNA MAC TRANSMISSION BEGINS AFTER VARIABLE ACCESS DELAY
HANDSET ASSEMBLES 80 SAMPLES INTO VoIP FRAME #N+1 AND QUEUES THE FRAME IN HPNA MAC
HPNA LAN DELIVERY LATENCY
3060
3054
3056
3052
3050
TIME->
3058
VoIP FRAME #N ARRIVAL AT CABLE MODEM
CABLE MODEM PROCESSES VoIP FRAME #N, PLACES IT INTO ITS UPSTREAM QUEUE
~5 MSEC
10 MSEC
10 MSEC

FIG. 72a

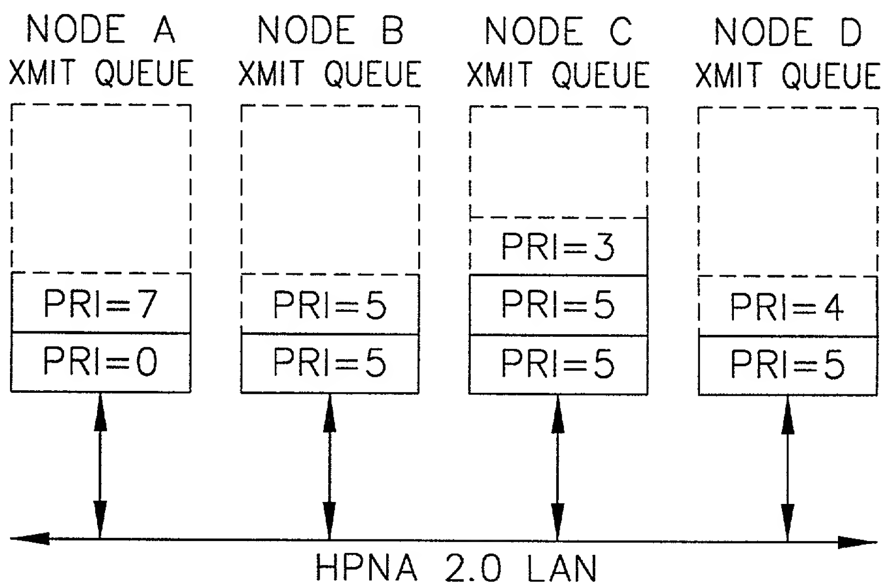


FIG. 72b

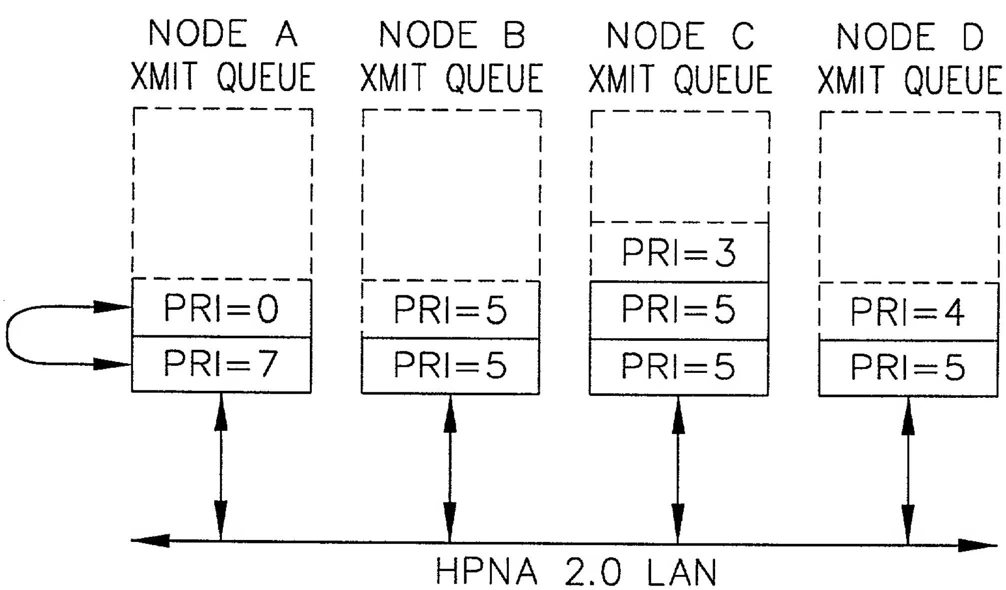


FIG. 73

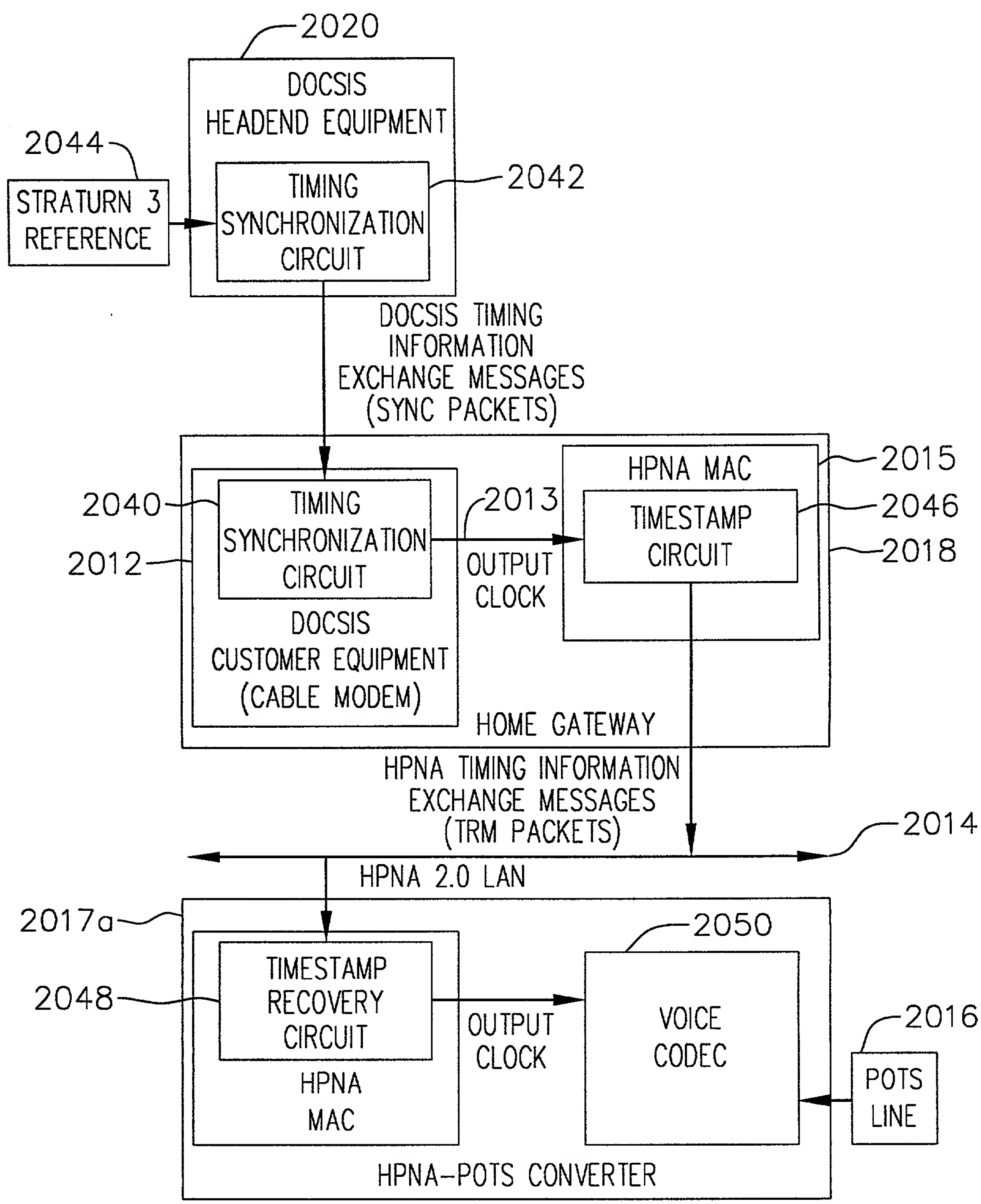

2020
DOCSIS
HEADEND EQUIPMENT
2044
STRATURN 3
REFERENCE
TIMING
SYNCHRONIZATION
CIRCUIT
2042
DOCSIS TIMING
INFORMATION
EXCHANGE MESSAGES
(SYNC PACKETS)
2015
HPNA MAC
2040
TIMING
SYNCHRONIZATION
CIRCUIT
2013
TIMESTAMP
CIRCUIT
2046
2018
2012
OUTPUT
CLOCK
DOCSIS
CUSTOMER EQUIPMENT
(CABLE MODEM)
HOME GATEWAY
HPNA TIMING INFORMATION
EXCHANGE MESSAGES
(TRM PACKETS)
2014
HPNA 2.0 LAN
2017a
2050
TIMESTAMP
RECOVERY
CIRCUIT
2048
OUTPUT
CLOCK
VOICE
CODEC
2016
POTS
LINE
HPNA
MAC
HPNA-POTS CONVERTER

FIG. 74

PARAMTER	UPSTREAM "10E-6 CASE	UPSTREAM 91% CASE	UPSTREAM 90% CASE	DOWNSTREAM "10E-6 CASE	DOWNSTREAM 91% CASE	DOWNSTREAM 90% CASE
ACCESS DELAY	3.1	1.3	1.3	3.1	1.3	1.3
COLLISION RESOLUTION	2.7	2.7	0.8	2.7	2.7	0.8
3 UP, 1 DOWN	2.1	1.0	1.0	2.1	1.0	1.0
LAST UP	0.5	0.3	0.3	0.5	0.3	0.3
COLLISION RESOLUTION	0.8	0.8	0.8	0.8	0.8	0.8
3 UP, 1 DOWN	2.1	1.0	1.0	2.1	1.0	1.0
LAST UP	0.5	0.3	0.3	0.5	0.3	0.3
3 DOWN				1.5	0.8	0.8
3 DOWN				1.5	0.8	0.8
TOTAL LATENCY	11.8	7.4	5.5	14.9	8.9	7.1

10E-6 CASE IS 10E-6 CRA ONCE OF TWO TRIES IN HOMES WITH MAXIMUM 4MBITS/SEC RAW RATE

91% CASE IS 10E-6 CRA ONCE OF TWO TRIES IN HOMES WITH MINIMUM 10MBITS/SEC RAW RATE

90% CASE IS 10E-1 CRA TWICE IN TWO TRIES IN HOMES WITH MINIMUM 10MBITS/SEC RAW RATE

VALUES IN THE TABLE ABOVE ARE IN MILLISECONDS.

OVERHEADS:

IFG	PER COLL	FRAME HDR	LARQ HDR	RTP_H DR	LINEAR PCM FRAME SIZE	5 NODES CRA 10E-6	5 NODES CRA 10E-1	5 NODES CRA FIXED
0.018 MSEC	0.206 MSEC	0.07 MSEC	8 BYTES	40 BYTES	160 BYTES	13 COLLISIONS	4 COLLISIONS	2 COLLISIONS

FRAME HEADER INCLUDES PREAMBLE, FC, DA, SA, T/L, EOF

FIG.75

PARAMTER	UPSTREAM "10E-6 CASE	UPSTREAM 91% CASE	UPSTREAM 90% CASE	DOWNSTREAM "10E-6 CASE	DOWNSTREAM 91% CASE	DOWNSTREAM 90% CASE
ACCESS DELAY	3.1	1.3	1.3	3.1	1.3	1.3
COLLISION RESOLUTION	0.4	0.4	0.4	0.4	0.4	0.4
3 UP, 1 DOWN	1.4	0.8	0.8	1.4	0.8	0.8
LAST UP	0.5	0.3	0.3	0.5	0.3	0.3
COLLISION RESOLUTION	0.0	0.0	0.0	0.0	0.0	0.0
3 UP, 1 DOWN	0.0	0.0	0.0	0.0	0.0	0.0
LAST UP	0.0	0.0	0.0	0.0	0.0	0.0
3 DOWN				1.1	0.6	0.6
3 DOWN				0.0	0.0	0.0
TOTAL LATENCY	5.5	2.7	2.7	6.5	3.3	3.3

Fig. 76

Field	Length	Meaning
DA	6 octets	Destination Address
SA	6 octets	Source Address
Ethertype	2 octets	(TBD) = VOHN Link Control Frame - new IEEE assignment
Type	2 octets	1 = Timestamp Sync Message
Length	2 octets	= 4
Version	2 octets	= 0
SeqNum	2 octets	Timestamp Sync Message Sequence Number
Pad		Any value octet
FCS	4 octets	Frame Check Sequence

Fig. 77(1)

Field	Length	Meaning
DA	6 octets	Destination Address
SA	6 octets	Source Address
Ethertype	2 octets	(TBD) = VOHN Link Control Frame - new IEEE assignment
Type	2 octets	2 = Timestamp Report Message
Length	2 octets	Number of additional octets in the signaling frame, starting with Version field and ending with the last octet of the Data Payload field. Minimum is 2.
Version	2 octets	= 0
TSMSeqNum	2 octets	Sequence number of TSM to which the Timestamp in this message is applicable.
Timestamp	4 octets	Timestamp of a previously transmitted Timestamp Report Message, corresponding to TSMSeqNum.
Frequency	2 octets	Resolution of the timestamp and Gtimestamp fields, in ticks/1.000ms. For example, value 32768 corresponds to one clock tick at 32.768Mhz, in which the LSBit of the Timestamp corresponds to a time of 0.030517578125usec. The Timestamp will rollover every 131 seconds = 2.2 minutes
NumGrants	2 octets	Number of Grant Timestamps specified in the payload of this control message. NumGrants may be zero. Each grant timestamp is accompanied by a Line ID and Call ID field. Including the Grant Timestamp, the total for each grant timestamp is 8 bytes.

Fig. 77(2)

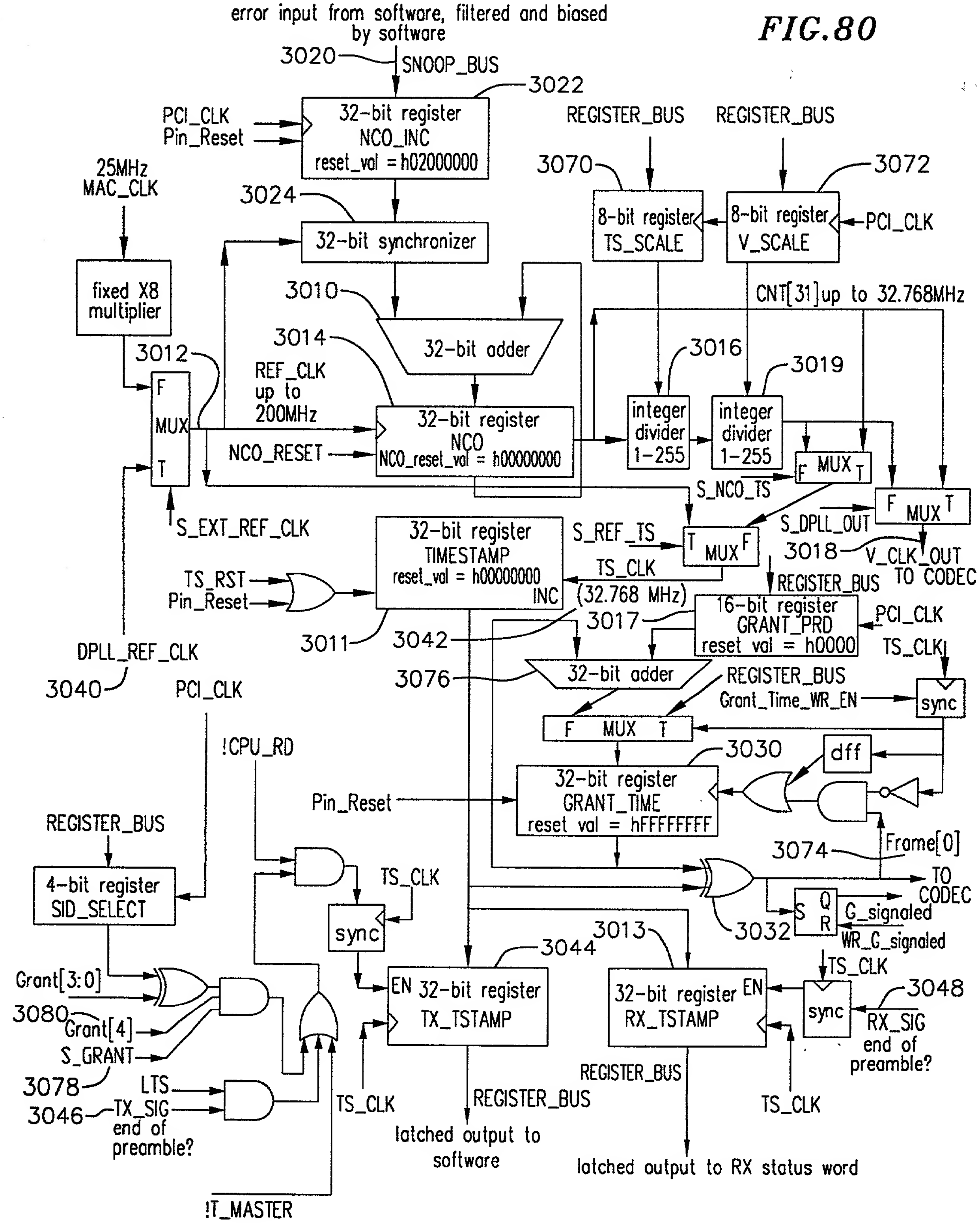
Line ID	2 octets	Identifier of the Line termination associated with the immediately following GTimestamp.
Call ID	2 octets	Identifier of the call instance on the Line termination associated with the immediately following GTimestamp.
GrantTimestamp	4 octets	Grant Timestamp corresponding to the immediately preceding Line ID. This is the time at which the Proxy Gateway wishes to receive a future constant bit rate service flow packet in order to minimize delivery latency to subsequent delivery to a synchronous network. The time value corresponds to the time at the timing master. Additional packets for the identified service flow are expected to arrive at periodic intervals measured from this time.
...		additional instances of {Line ID, Call ID, Grant Timestamp} field tuples
Pad		Any value octet
FCS	4 octets	Frame Check Sequence

Fig. 78

PIN NAME	CM-side Function (HPNA timing master)		Handset Function (HPNA timing slave)	
DPLL_REF_CLK	DPLL input clock	IN		
Grant[4]	Grant Present Indication	IN		
Grant[3]	Grant SID Value[3]	IN		
Grant[2]	Grant SID Value[2]	IN		
Grant[1]	Grant SID Value[1]	IN		
Grant[0]	Grant SID Value[0]	IN		
V_CLK_OUT			DPLL output clock	OUT
GPI[0]			Grant Present Indication[0]	OUT
GPI[1]			Grant Present Indication[1]	OUT

Fig. 79

PIN NAME	CM-side Function (HPNA timing master)		Handset Function (HPNA timing slave)	
DPLL_REF_CLK	DPLL input clock	IN		
Grant[4]	Grant Present Indication	IN		
Grant[3]	Grant SID Value[3]	IN		
Grant[2]	Grant SID Value[2]	IN		
Grant[1]	Grant SID Value[1]	IN		
Grant[0]	Grant SID Value[0]	IN		
V_CLK_OUT			DPLL output clock	OUT
Frame[0]			Frame boundary marker[0]	OUT
Frame[1]			Frame boundary marker[1]	OUT



error input from software, filtered and biased by software
3020
SNOOP_BUS
3022
PCI_CLK
Pin_Reset
32-bit register
NCO_INC
reset_val = h02000000
25MHz
MAC_CLK
3024
32-bit synchronizer
fixed X8 multiplier
REGISTER_BUS
REGISTER_BUS
3070
3072
8-bit register
TS_SCALE
8-bit register
V_SCALE
PCI_CLK
3010
32-bit adder
CNT[31]up to 32.768MHz
3014
3012
REF_CLK
up to
200MHz
F
MUX
T
32-bit register
NCO
NCO_reset_val = h00000000
NCO_RESET
3016
integer divider 1-255
3019
integer divider 1-255
S_NCO_TS
S_EXT_REF_CLK
32-bit register
TIMESTAMP
reset_val = h00000000
INC
S_REF_TS
S_DPLL_OUT
3018
V_CLK_OUT
TO CODEC
TS_RST
Pin_Reset
TS_CLK
(32.768 MHz)
REGISTER_BUS
16-bit register
GRANT_PRD
reset_val = h0000
PCI_CLK
TS_CLK
DPLL_REF_CLK
3011
3042
3017
3040
PCI_CLK
3076
32-bit adder
REGISTER_BUS
Grant_Time_WR_EN
sync
!CPU_RD
3030
dff
Pin_Reset
32-bit register
GRANT_TIME
reset_val = hFFFFFFFF
REGISTER_BUS
4-bit register
SID_SELECT
3074
Frame[0]
TS_CLK
TO CODEC
sync
S
Q
R
G_signaled
WR_G_signaled
3032
3013
3044
Grant[3:0]
3080
Grant[4]
S_GRANT
EN 32-bit register
TX_TSTAMP
32-bit register EN
RX_TSTAMP
TS_CLK
3048
sync
RX_SIG
end of preamble?
3078
LTS
3046
TX_SIG
end of preamble?
TS_CLK
REGISTER_BUS
latched output to software
REGISTER_BUS
TS_CLK
latched output to RX status word
!T_MASTER

FIG. 80

FIG. 81

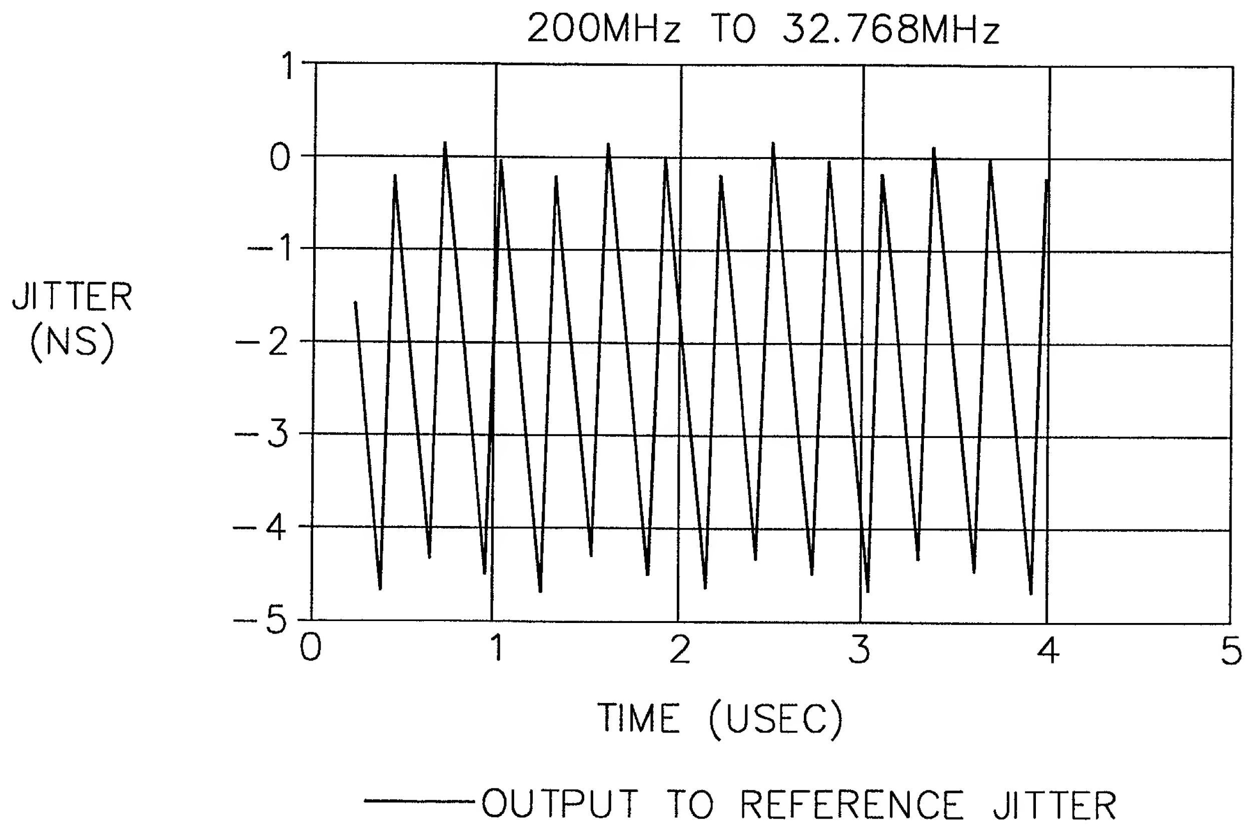

200MHz TO 32.768MHz
JITTER (NS)
1
0
−1
−2
−3
−4
−5
0
1
2
3
4
5
TIME (USEC)
OUTPUT TO REFERENCE JITTER

FIG. 82

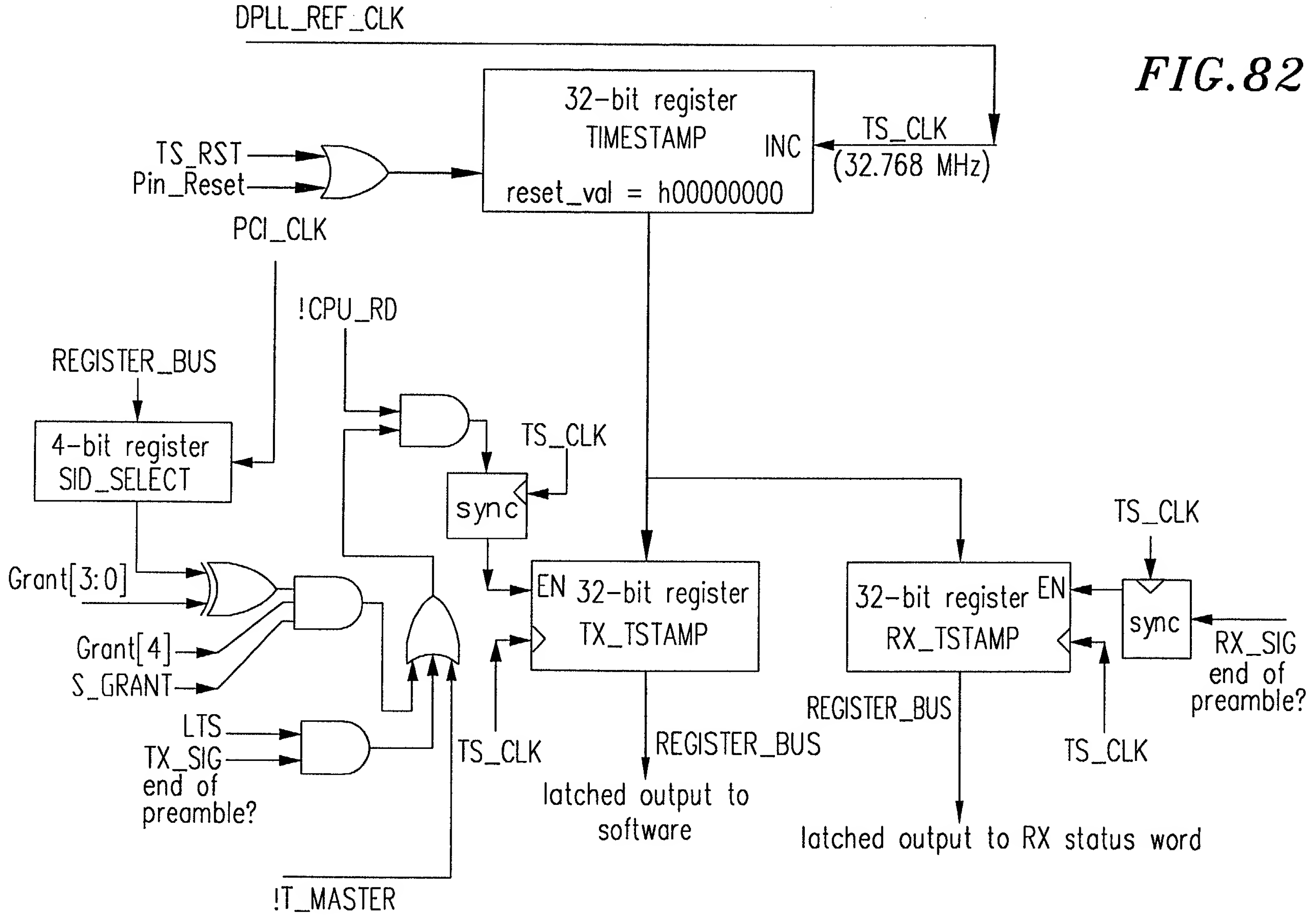

DPLL_REF_CLK
32-bit register
TIMESTAMP
INC
reset_val = h00000000
TS_CLK
(32.768 MHz)
TS_RST
Pin_Reset
PCI_CLK
!CPU_RD
REGISTER_BUS
4-bit register
SID_SELECT
TS_CLK
sync
Grant[3:0]
Grant[4]
S_GRANT
LTS
TX_SIG
end of
preamble?
EN
32-bit register
TX_TSTAMP
TS_CLK
REGISTER_BUS
latched output to
software
!T_MASTER
32-bit register
RX_TSTAMP
EN
TS_CLK
sync
RX_SIG
end of
preamble?
REGISTER_BUS
TS_CLK
latched output to RX status word

Fig. 83a

PIN NAME	CM-side Function (HPNA timing master)		Handset Function (HPNA timing slave)	
DPLL_REF_CLK	Timestamp input clock	IN	Timestamp input clock	
Grant[4]	Grant Present Indication	IN	NA	
Grant[3]	Grant SID Value[3]	IN	NA	
Grant[2]	Grant SID Value[2]	IN	NA	
Grant[1]	Grant SID Value[1]	IN	NA	
Grant[0]	Grant SID Value[0]	IN	NA	

Fig. 83b

Bit locations	Field name	Description
7-3	Reserved	
2	TsReset	When set to 1, forces timestamp register to value of 0x00000000. When set to 0, allows timestamp register to increment by one for each detected DPLL_REF_CLK rising edge.
1	SGrant	When set to 1, causes timestamp to be latched into txTimeStampHigh and txTimeStampLow registers whenever the value of tscSID matches the value of input pins Grant[3:0] and Grant[4] is asserted. When set to 0, disables txTimeStampHigh and txTimeStampLow latching under the stated conditions.
0	TMaster	When set to 1, enables txTimestampHigh and txTimestampLow registers to be latched with timestamp values at times determined by frame transmissions (through the LTS descriptor bit) or grant events (through the sGrant descriptor bit). When set to 0, enables txTimestampHigh and txTimestampLow registers to be latched with timestamp values at times determined by txTimeStampHigh and txTimeStampLow register read accesses.

Default value of this register is 0x05

Bit locations	Field name	Description
7-4	Reserved	
3-0	SID	SID value that is to be matched by Grant[3:0] pins in order to cause a grant timestamp value to be latched. When the Grant[3:0] pins match the SID value and the Grant[4] input is 1 and the sGrant register bit is 1, then the current timestamp value will be latched into the txTimeStampHigh and txTimeStampLow registers.

Default value of this register is 0x00

Fig. 83c

Fig. 83d

Bit locations	Field name	Description
15-0	txTimeStampLow	Least significant 16 bits of the latched tx timestamp value

Default value of this register is undefined.

Fig. 83e

Bit locations	Field name	Description
15-0	txTimeStampHigh	Most significant 16 bits of the latched tx timestamp value

Default value of this register is undefined.

Fig. 83f

Bit locations	Field name	Description
15-0	rxTimeStampLow	Least significant 16 bits of the latched rx timestamp value

Default value of this register is undefined.

Fig. 83g

Bit locations	Field name	Description
15-0	rxTimeStampHigh	Most significant 16 bits of the latched rx timestamp value

Default value of this register is undefined.

FIG.84a

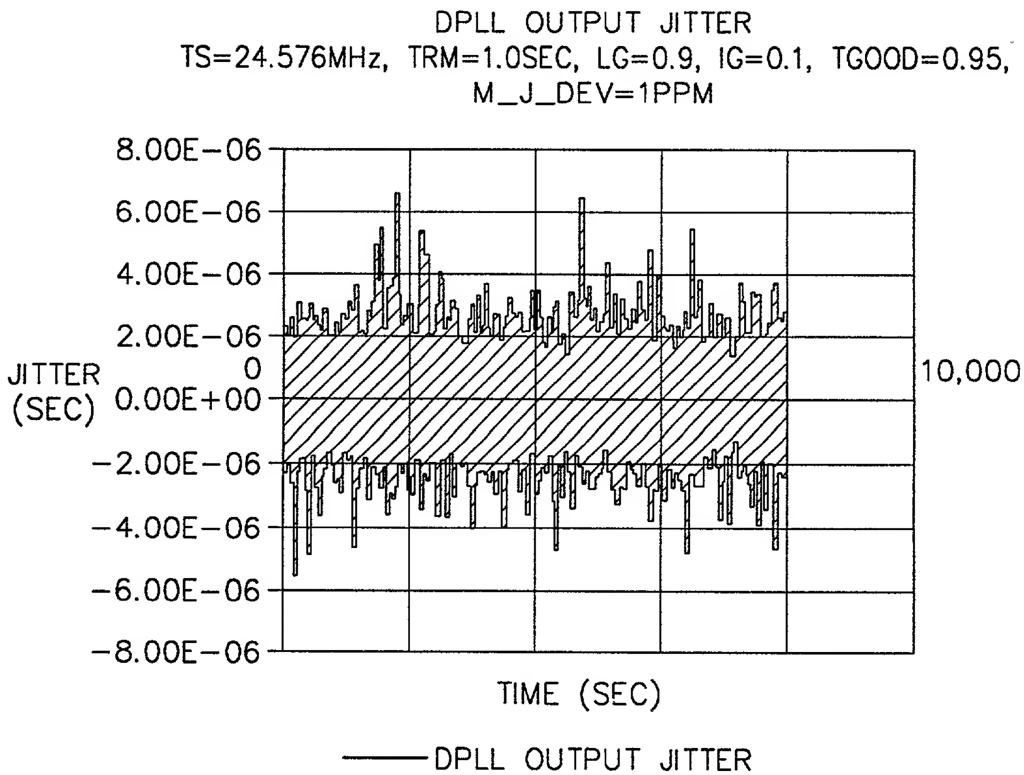


FIG.84b

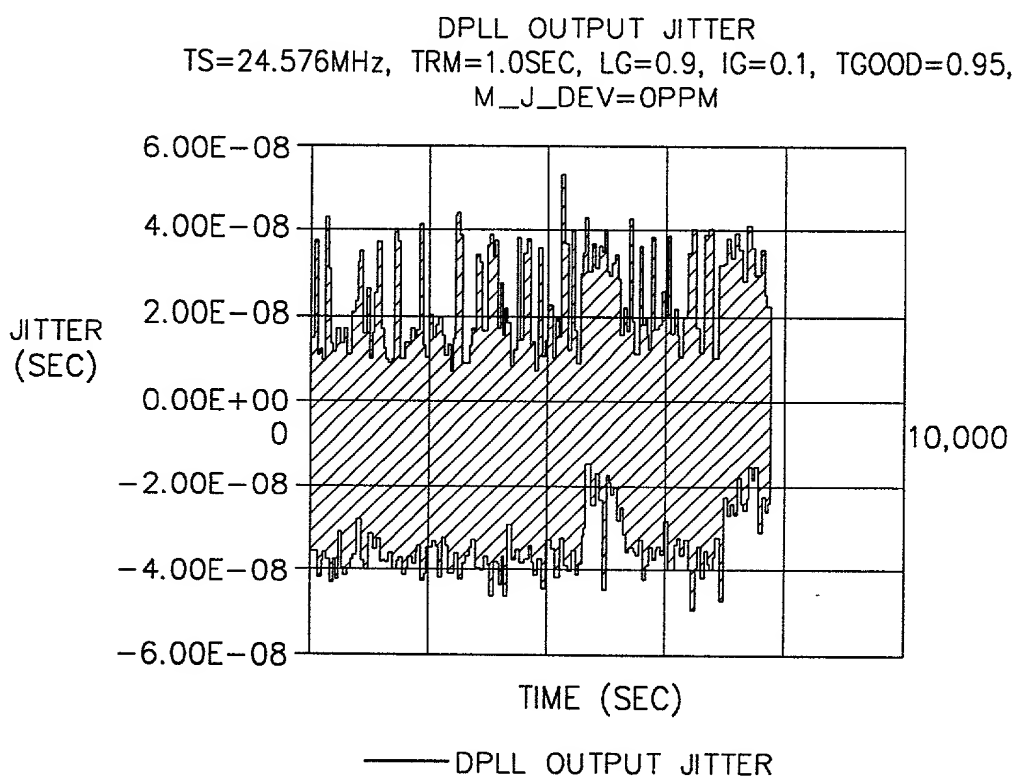


Fig. 85(1)

Field	Length	Meaning
DA	6 octets	Destination Address (FF.FF.FF.FF.FF.FF)
SA	6 octets	Source Address
Ethertype	2 octets	0x886c (HPNA Link Control Frame)
SSType	1 octet	= TBD
SSLength	1 octet	Number of additional octets in the control header, starting with the SSVersion field and ending with the second (last) octet of the Next Ethertype field. Minimum is 16.
SSVersion	1 octet	= 0
TRM_type	1 octet	Value of x00 means that this is a TRM containing a valid timestamp. Value of x01 means that the master does not have a valid clock and slaves should give local indication that they are no longer locked to a master reference. Value of x80 means that this is a TQM. Value of x81 means that this is a TSM. All other values are reserved.
TRMSeqNum	2 octets	Timestamp Report Message Sequence Number for this message. Sequence number of x0000 indicates an initial TRM, implying that Timestamp and PrevTRMSeqNum are both invalid.
PrevTRMSeqNum	2 octets	Sequence number of TRM to which the Timestamp in this message is applicable. The value of PrevTRMSeqNum is *not* necessarily equal to TRMSeqNum minus one. PrevTRMSeqNum is set to x0000 for the first TRM of a TRM pair.

Fig. 85(2)

Field	Length	Meaning
Timestamp	4 octets	Timestamp of a previously transmitted Timestamp Report Message, corresponding to PrevTRMSeqNum. The LSBit of the Timestamp corresponds to a time of 0.030517578125μsec = one clock tick at 32.768MHz. The Timestamp will rollover every 131 seconds = 2.2 minutes.
NumSlots	1 octet	Number of Slot Timestamps specified in the payload of this control message. NumSlots may be zero. Each Slot Timestamp is accompanied by a MACAddr, and Channel_ID field. Including the Slot Timestamp, each Slot Timestamp is 12 bytes long.
PAD_0	3 octets	Padding to align to a 32-bit boundary. Always present, even when NumSlots has the value of 0.
MACAddr	6 octets	MAC Address associated with the immediately following Channel_ID and STimestamp.
Channel_ID	2 octets	Identifier for a channel associated with the immediately preceding MACAddr.
STimestamp	4 octets	Slot Timestamp corresponding to the immediately preceding Channel_ID. This is the time at which the TRM sender wishes to receive a future constant bit rate service flow packet in order to minimize overall latency of delivery to a synchronous network. The time value corresponds to the time at the timing master. Additional packets for the identified service flow are expected to arrive at periodic intervals measured from this time. The LSBit of the STimestamp corresponds to a time of 0.030517578125μsec = one clock tick at 32.768MHz.
MACAddr	6 octets	MAC Address associated with the immediately following Channel-ID and STimestamp.
Channel_ID	2 octets	Identifier for a channel associated with the immediately following Channel_ID and STimestamp.

Fig. 85(3)

Field	Length	Meaning
STimestamp	4 octets	Slot Timestamp corresponding to the immediately preceding Channel_ID. This is the time at which the TRM sender wishes to receive a future constant bit rate service flow packet in order to minimize overall latency of delivery to a synchronous network. Additional packets for the identified service flow are expected to arrive at periodic intervals measured from this time. The LSBit of the STimestamp corresponds to a time of 0.030517578125μsec = one clock tick at 32.768 MHz.
...		[additional instances of MACAddr, Channel_ID and Gtimestamp fields, until the number of Gtimestamp fields equals NumGrants]
Next Ethertype	2 octets	= 0
Pad	max (0,44-SSLength octets	Any value octet
FCS	4 octets	

Fig. 86

Field	Length	Meaning
DA	6 octets	Destination Address (FF.FF.FF.FF.FF.FF)
SA	6 octets	Source Address
Ethertype	2 octets	0x886c (HPNA Link Control Frame)
SSType	1 octet	= 6
SSLength	1 octet	Number of additional octets in the control header, starting with the SSVersion field and ending with the second (last) octet of the Next Ethertype field. Minimum is 4.
SSVersion	1 octet	= 0
TRM_type	1 octet	Value of x80 means that this is a TQM.
Next Ethertype	2 octets	= 0
Pad	MIN(0,40-SSLength) octets	Any value octet
FCS	4 octets	

Fig. 87

Field	Length	Meaning
DA	6 octets	Destination Address (FF.FF.FF.FF.FF.FF)
SA	6 octets	Source Address
Ethertype	2 octets	0x886c (HPNA Link Control Frame)
SSType	1 octet	= 6
SSLength	1 octet	Number of additional octets in the control header, starting with the SSVersion field and ending with the second (last) octet of the Next Ethertype field. Minimum is 4.
SSVersion	1 octet	= 0
TRM_type	1 octet	Value of x81 means that this is a TSM.
Next Ethertype	2 octets	= 0
Pad	MIN(0,40-SSLength) octets	Any value octet
FCS	4 octets	

FIG.88

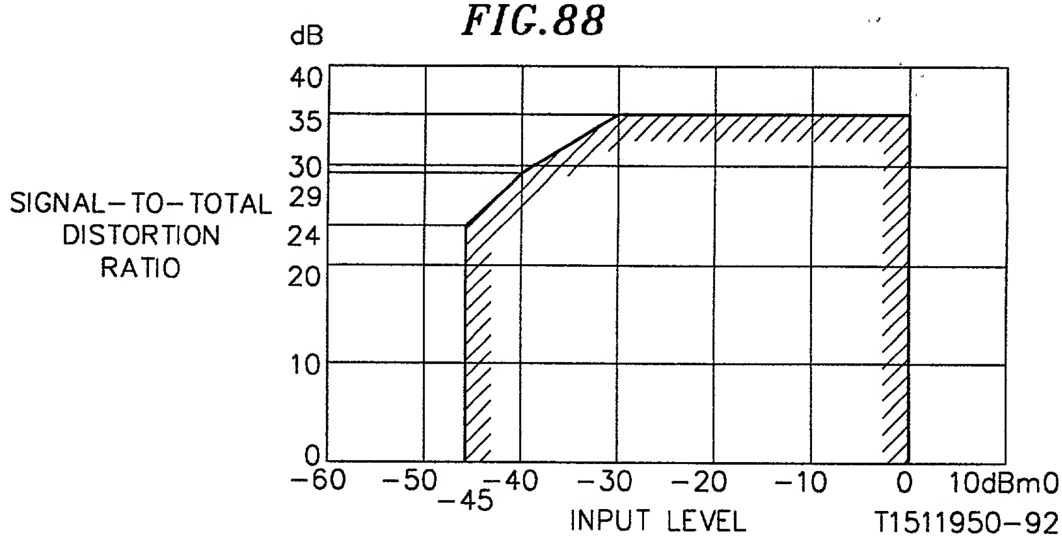


FIG.89a

INPUT LEVEL	UNIFORM QUANTIZER +COMPANDER SNR	THE REQUIRED SNR FOR ADC/DAC
0dBm	38.43dB	60dB
-30dBm	35.50dB	54dB
-40dBm	30.09dB	44dB

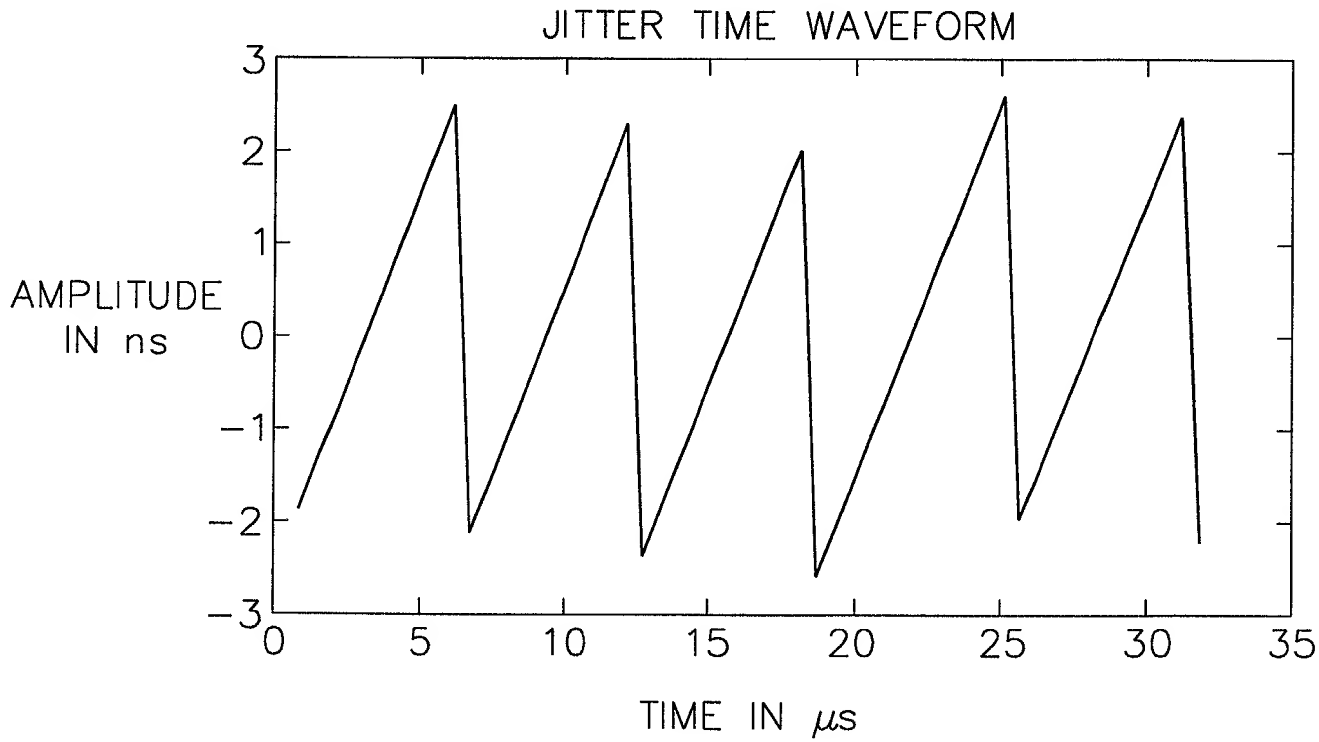
FIG.89b

INPUT LEVEL	G.712 SNR SPEC	THE TOTAL SNR WITH UNIFORM QUANTIZER+COMPANDER+JITTER CLOCK
0dBm	35dB	38.32dB (60dB ADC/DAC SNR IS USED)
-30dBm	35dB	35.42dB (54dB ADC/DAC SNR IS USED)
-40dBm	29dB	30.05dB (44dB ADC/DAC SNR IS USED)

FIG.89c

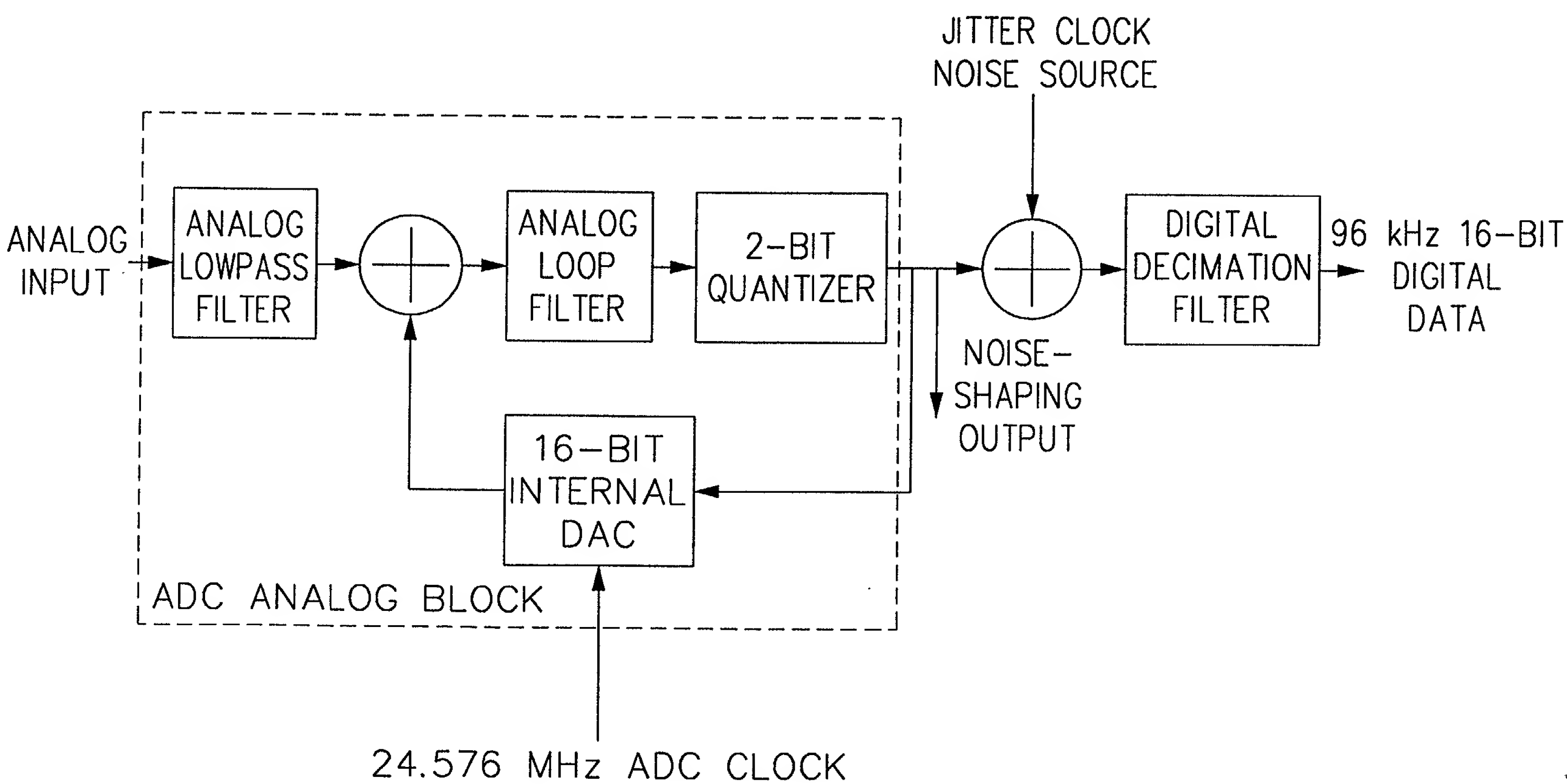
INPUT LEVEL	G.712 SNR SPEC	THE TOTAL SNR WITH UNIFORM QUANTIZER+COMPANDER+JITTER CLOCK
0dBm	35dB	38.38dB (60dB ADC/DAC SNR IS USED)
-30dBm	35dB	35.26dB (54dB ADC/DAC SNR IS USED)
-40dBm	29dB	30.03dB (44dB ADC/DAC SNR IS USED)

FIG.90



JITTER TIME WAVEFORM
AMPLITUDE IN ns
3
2
1
0
−1
−2
−3
0
5
10
15
20
25
30
35
TIME IN μs

FIG.91



ANALOG INPUT
ANALOG LOWPASS FILTER
ANALOG LOOP FILTER
2-BIT QUANTIZER
16-BIT INTERNAL DAC
ADC ANALOG BLOCK
24.576 MHz ADC CLOCK
JITTER CLOCK NOISE SOURCE
NOISE-SHAPING OUTPUT
DIGITAL DECIMATION FILTER
96 kHz 16-BIT DIGITAL DATA

FIG. 92

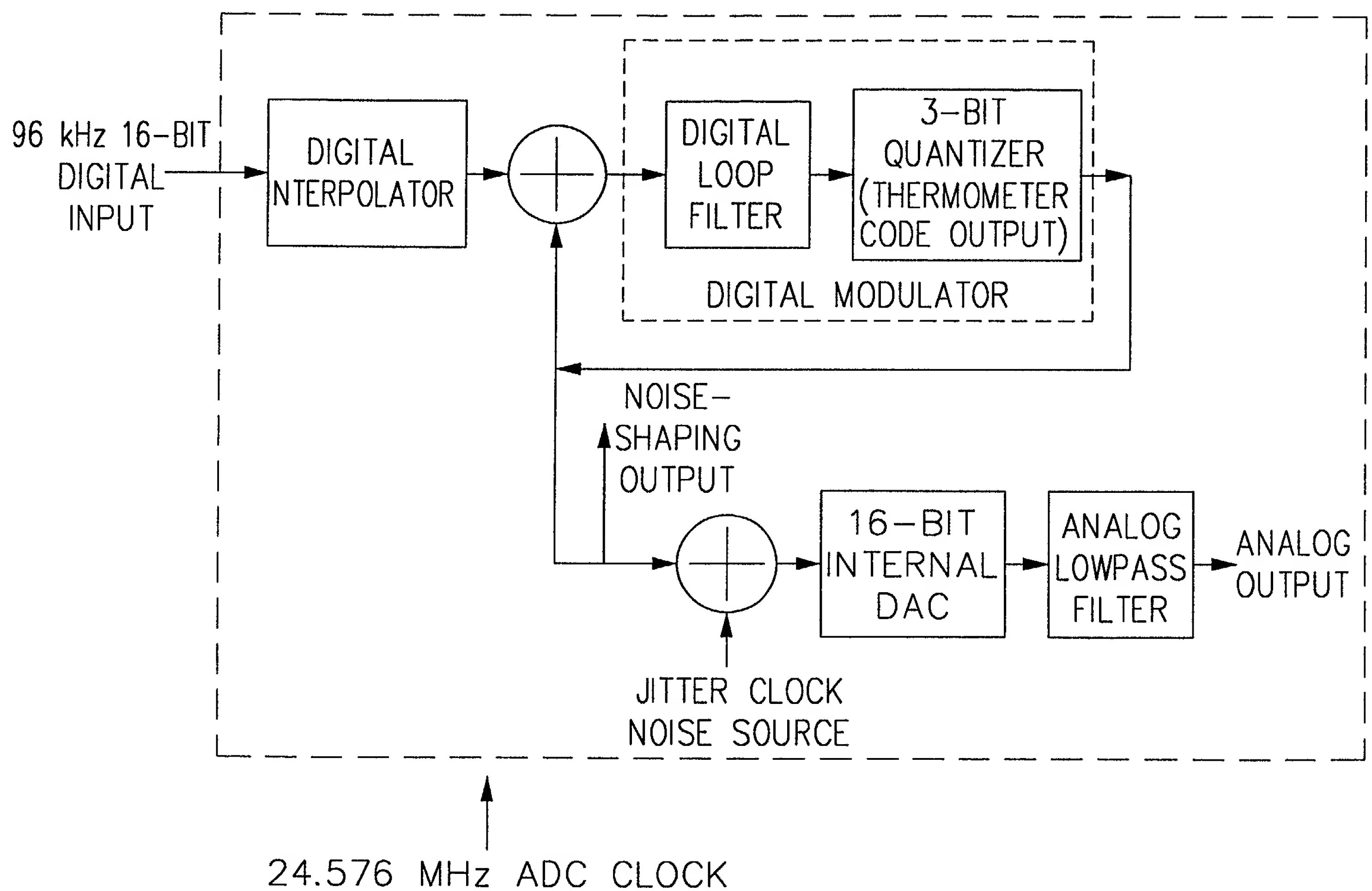

96 kHz 16-BIT
DIGITAL
INPUT
DIGITAL
NTERPOLATOR
DIGITAL
LOOP
FILTER
3-BIT
QUANTIZER
(THERMOMETER
CODE OUTPUT)
DIGITAL MODULATOR
NOISE-
SHAPING
OUTPUT
16-BIT
INTERNAL
DAC
ANALOG
LOWPASS
FILTER
ANALOG
OUTPUT
JITTER CLOCK
NOISE SOURCE
24.576 MHz ADC CLOCK

Fig. 93(1)

Octet	Field	Length	Description
Flags 0	TxPriority7	1	Station is (was) transmitting frames with LL priority 7. (always set)
	TxPriority6	1	Station is (was) transmitting frames with LL priority 6.
	TxPriority5	1	Station is (was) transmitting frames with LL priority 5.
	TXPriority4	1	Station is (was) transmitting frames with LL priority 4.
	TxPriority3	1	Station is (was) transmitting frames with LL priority 3.
	TxPriority2	1	Station is (was) transmitting frames with LL priority 2.
	TxPriority1	1	Station is (was) transmitting frames with LL priority 1.
	TxPriority0	1	Station is (was) transmitting frames with LL priority 0. (always set)
Flags 1	Reserved	5	Shall be sent as 0 and ignored by 2.0 stations when received.
	CSS_Master_Capability	1	This station is capable of operating as a CSS Master node.
	No_V1M2_Frames	1	This station does not support the reception or transmission of compatibility frames (V1M2 frames).
	Supports 4Mbaud	1	This station supports 4 megabaud payload encodings.
Flags 2	Reserved	8	Shall be sent as 0 and ignored by 2.0 stations when received.
Flags 3	ConfigV2	1	Force use of 10M8 mode, defers to Config1 and ConfigV1Ms.
	ConfigV1M2	1	Force use of HPNA V1M2 mixed mode, defers to ConfigV1.

Fig. 93(2)

Octet	Field	Length	Description
	ConfigV1	1	Force use of HPNA 1.x mode, highest precedence of config flags.
	Reserved	2	Shall be sent as 0 and ignored by 2.0 stations when received.
	Highest Version	3	This station's highest supported HPNA version: 0x000 -- Reserved 0x001 -- HPNA 1.0 0x010 -- HPNA 2.0 0x001-0x111 Reserved

Fig. 94

Field	**Lengt h**	**Meaning**
CSEType	1 octet	X00 = signifies a CSS Extension type
CSELength	1 octet	X08 = Number of additional octets in this CSEType. CSELength is always x08 for CSEType = x00 = CSS
CSS_MAC	6 octet s	MAC address of client station
CSS_SEQ	2 octet s	CSS sequence, 8 two-bit values concatenated: 0-2 indicate a specific signaling slot, while 3 indicates the use of a randomly selected value chosen by the client at the time of the collision. X0000 - xBFFF = assigned CSS_SEQ value for the node possessing the MAC address specified in CSS_MAC XC000 - xFEFF = reserved XFF00 = indication by the client node specified by CSS_MAC that it is no longer an active sender of link layer priority 6 frames (equivalent to a "0 active channels" indication) XFF01 - xFFFE = request by the client node specified by CSS_MAC for a CSS Sequence from the master node. The 8 Least significant bits indicate the number of active channels which are sending link layer. priority 6 frames for this client. XFFFF - reserved

Fig. 95

2-bit CSS register value (binary)	Signal slot integer (decimal)
00	0
01	1
10	2
11	Random in range [0,2]

Bit Number	Value
7:0	**Station Type:** 0 – HomePNA 1.x station 1 – 10M8 station in V1M2 Mode 2 – 10M8 station in V1M2 Mode, that has detected a recent 1M8 transmission with PCOM Station Type = 0 Other values reserved
31:8	Reserved, must be 0 on transmission

Fig. 96

Precedence	Variable
1	ConfigV1
2	ConfigV1M2
3	ConfigV2
4	V1_DETECTED
4	V1_SIGNALED

Fig. 97